
JOURNAL
OF THE
ARNOLD ARBORETUM

VOL. XXX

JANUARY 1949

NUMBER 1

ADDITIONAL NOTES ON *DEGENERIA VITIENSIS*

A. C. SMITH

With one plate and one text-figure

WHEN THE FAMILY Degeneriaceae was proposed in 1942 (in Jour. Arnold Arb. 23: 356-365. *pl.* 1-5) by Prof. I. W. Bailey and the writer, it must have seemed to some readers that we were highly optimistic in suggesting that a new species based on only two known collections be immediately established as representing a monotypic family. Few plant families have such an abrupt inception. It is more traditional to refer a genus of doubtful affinities to some presumably allied family, in which it may languish for many years or decades, until the researches of monographers exclude it from all likely families and establish that it merits family rank. Even then the position of the genus is suspect, for many herbarium custodians are allergic to monotypic or small families and, rather than alter their system, cling to unwieldy plant-groupings which have no morphological justification. Whether the family Degeneriaceae will be accepted in herbaria or will be thrust into a distended "magnoliaceous" concept (which already in some herbaria includes highly discordant elements) remains to be seen.

However, in 1942 Prof. Bailey and I could not bring ourselves to place our new genus *Degeneria* in either the Magnoliaceae or Himantandraceae, clearly the only existing families of its immediate alliance. The discovery of a third collection, from southeastern Viti Levu (cf. Bull. Torrey Club 70: 537. 1943), did not add to our knowledge of the morphology of the genus. In order to verify our conclusions or to make possible a re-evaluation of our family concept, new material for morphological and anatomical study was clearly desirable. Consequently, when I had an opportunity to undertake a second collecting trip to Fiji in 1947,¹ one of

¹ The collections upon which this study is primarily based were obtained in Fiji between April, 1947, and January, 1948, in the course of exploration under the auspices of the Arnold Arboretum of Harvard University. Generous financial support was supplied by the John Simon Guggenheim Memorial Foundation, the Penrose Fund of the American Philosophical Society, and the Bache Fund of the National Academy of Sciences. To these organizations the writer is deeply grateful.

my primary objectives was to locate, if possible, additional specimens of *Degeneria vitiensis* and to obtain material for study by my colleagues Prof. Bailey and Dr. B. G. L. Swamy. It is not within the scope of this treatment to discuss in detail the morphological aspects of *Degeneria*, now somewhat better known than in 1942, which justify its position in a distinct family. In the following article in this Journal, Dr. Swamy ably analyzes the characters of our genus. Here I shall refer only to the occurrence, habit, and habitat of *Degeneria vitiensis*, on the basis of my field-study of it in 1947.

OCCURRENCE

The principal purpose of the Fijian exploration mentioned above was the acquisition of herbarium material which would permit a better knowledge of the flora and which would widen the basis for future floristic studies of the archipelago. Consequently I attempted to visit those regions which had been comparatively neglected by previous collectors. The first six months were spent on Viti Levu, for the most part at higher elevations. My first objectives were the two forested mountain-ranges which stand above the predominantly reed-covered western portion of Viti Levu—the Mt. Evans and Mt. Koromba Ranges. During two months in this area no specimens of *Degeneria* were found. Subsequently a base was established at Nandarivatu, a now nearly deserted government station on the northern escarpment of Viti Levu at an elevation of about 800 meters. From this base numerous trips southward, into the extensive forested area drained by the upper Singatoka River, were made. During June and July the forested area dominated by Fiji's highest peak, Tomanivi [Mt. Victoria], was explored without observation of *Degeneria*. Degener's type-locality is in the vicinity of a small Fijian settlement, Nauwanga, which lies in the valley of Nandala Creek (one of the Singatoka headwaters) a few miles south of Nandarivatu; I did not work in that immediate vicinity in detail.

Due to other interests, I had relegated the search for *Degeneria* to a lesser position when I began to work southward from Tomanivi onto the Rairaimatuku Plateau, a poorly drained, uninhabited, and essentially uncollected upland region, about 25 by 15 miles in size, occupying the center of Viti Levu. It was, therefore, an exciting surprise to find the desired species. Collectors will agree with me that the rediscovery of a rare plant gives an emotional pleasure incomparably greater than its original discovery, at which time it is unexpected and usually unrecognized. For my part, I have no remembrance whatever of my first collection of *Degeneria* on Vanua Levu in 1934. But the date (August 7, 1947) and the place of my second collection of the species will not be forgotten by me. From my headquarters in the village of Nandrau, which lies on the steep western slope of the plateau in the Singatoka valley, I was working toward the smaller village of Nanga, which is similarly situated a few miles to the south. The trail between these villages leads through the dense forest of the plateau a mile or two from its edge. We had left this trail and were

slowly progressing through the forest toward the east, over the rounded summit of a small elevation, when one of my Fijian assistants brought me a strange fruit from the forest-floor. (It is fortunate for most of us who collect in tropical forests that we have keen-eyed native helpers, without whom we would overlook many discoveries for which our herbarium-labels unblushingly give us the credit.) After we located the tree — and this was not easy in the dense-foliaged rain-forest — I had plenty of time to compose myself, for it proved to be one of those stubborn trees, bound to others by lianas, which takes half an hour to fell. Once the tree was down and I had reassured myself it was really a specimen of the elusive *Degeneria*, we searched it thoroughly and obtained material for numerous herbarium specimens.

This individual was in the same condition as my Vanua Levu collection, with small fruits in the stage of development which Prof. Bailey and I had erroneously assumed to be mature in our original study. None of my field-crew had seen the species before, but in the village of Nanga one old man assured us that it was very rare but that he knew it by the name of *vavaloa*, which can be translated as "black shoe." The aptitude of this name is apparent only when one has seen the mature fruit.² In other parts of Fiji the species appears to be known as *yarangele* (in the Wainunu region of Vanua Levu) or *masiratu* (in southern Naitasiri, Viti Levu).

My field-crew, now being aware of the identity of the plant and of my desire for adequate flowering material, sought carefully for additional specimens, but none were forthcoming on the Rairaimatuku Plateau. However, after we had returned to the vicinity of Tomanivi we discovered the species with increasing frequency, as it became more familiar to us. On September 2, not far from a sawmill which operates at the western base of Tomanivi, we found individuals in full flower and with mature fruits. Later, we found the species in some abundance very near Nandarivatu, in the precise locations which had earlier been searched in vain. The area immediately adjacent to Nandarivatu and Tomanivi has been examined by several highly competent collectors, including Gibbs, im Thurn, Gillespie, and Degener. That none of them except the last obtained specimens of this genus need cause no surprise. Like most trees of the upper storey of the rain-forest, the *vavaloa* mingles its branches and foliage with those of many other species, and even when the tree is in full flower or fruit these organs are not visible from the ground. It is only an occasional clue — a fruit or the vascular skeleton of one on the forest-floor — that indicates the presence of the plant, and such clues can readily be overlooked or ignored by one unfamiliar with the plant. Eventually my Fijian friends learned to recognize *Degeneria* at a glance by its bark, but I believe that only a trained forester could equal them in this respect.

² I have also recorded the name *vavaloa* as applied, on one occasion, to *Oxymitra monosperma*, which has a fairly large inequilateral mature carpel, and on another occasion to *Hernandia olivacea*. There is no literal reason for the latter application, and my informant was probably over-enthusiastic.

Altogether I observed and made notes upon 55 trees of *Degeneria* during August, September, and October of 1947. From ten of these herbarium specimens were taken, in addition to wood samples and abundant material in preservative. It is obvious that the observed individuals form only a minute fraction of the total population; there must be many thousands of *Degeneria* trees in the region explored. This region may be defined as the northern part of the forest which covers the central portion of Viti Levu, and it may be circumscribed by a semi-circle, with a radius of less than 15 miles, lying due south of Nandarivatu. The area would fall into the old Province of Tholo North, now divided among the four Provinces of Mba, Nandronga & Navosa, Ra, and Naitasiri.

Degeneria vitiensis can no longer be considered rare in upland Viti Levu, but of course it cannot be described as common when compared with some of the characteristic species listed later in this paper. To the southward and southeastward of the region discussed above the forest seems essentially similar, and it is likely that the same frequency of *Degeneria* would be maintained on the entire central plateau of the island and in the forests drained by the Rewa and Navua tributaries. In favorable localities it occurs close to sea-level, as attested by Mr. B. E. Parham's collections of it in southeastern Viti Levu and my own in Vanua Levu.

It seems advisable to list here all the herbarium specimens of *Degeneria vitiensis* at present known; they are arranged in general from north to south on Viti Levu. My own 1947 collections are deposited in the herbarium of the Arnold Arboretum, and numerous duplicates will later be distributed. Mr. Parham's collections are in the herbarium of the Department of Agriculture, Suva, with duplicates at the Arnold Arboretum.

VITI LEVU: Mba: Hills between Nandala and Nukunuku Creeks, along trail from Nandarivatu toward Lewa, alt. 750–850 m., *Smith* 6170, 6190; western slopes of Mt. Nanggaranambuluta [Lomalangi], east of Nandarivatu, alt. 850–900 m., *Smith* 6301, 6318; hills east of Nandala Creek, about 3 miles south of Nandarivatu, alt. 850–950 m., *Smith* 5923; Nauwanga, valley of Nandala Creek south of Nandarivatu, alt. 750 m., *Degener* 14537 (TYPE, Arnold Arb.; duplicates widely distributed), Feb. 24, 1941; hills between Nggaliwana and Tumbeindreketi Creeks, east of the sawmill at Navai, alt. 750–800 m., *Smith* 5875, 5880, 6018 (juvenile); southwestern slopes of Mt. Tomanivi (Mt. Victoria), alt. about 850 m., *Smith* 5744; Nandronga & Navosa: Northern portion of Rairaimatuku Plateau, between Nandrau and Nanga, alt. 725–835 m., *Smith* 5555; Naitasiri: Nanduna, Waindina River, Navuakethe district, alt. 90–120 m., *B. E. Parham* 1488 (March 7, 1939), 3008 (June 19, 1945).³ VANUA LEVU: Mbua: Lower Wainunu River valley, alt. 0–200 m., *Smith* 1754 (duplicates in several herbaria), May 7, 1934.

These localities are indicated on the accompanying map (fig. 1), which also shows in an extremely approximate manner the boundary between

³ Mr. Parham kindly arranged to have a Fijian assistant in the Department of Agriculture, Apenito Gonekalou, visit this same locality on Jan. 4, 1948. Several trees were observed but no flowers or fruits could be obtained. However, Apenito obtained several seedlings, which were preserved in FAA and which have been studied by Prof. Bailey and Dr. Swamy. My own several attempts to germinate seeds at Nandarivatu failed, and seeds which were returned to Harvard by air-mail likewise proved unviable.

forest and grassland. Actually, of course, this boundary is a fairly wide and complex transitional zone.



FIG. 1. Sketch map of western Fiji (Lau Group omitted), showing known stations for *Degeneria vitiensis*. The dotted lines show the approximate boundaries, on the two large islands, between forested and grassland areas.

To summarize this discussion of the occurrence of *Degeneria vitiensis*, field-observations lead me to suppose that it may eventually be found in any undisturbed rain-forest area of Viti Levu and Vanua Levu between sea-level and approximately 950 meters. It should also be sought in the forested regions of the islands of Taveuni, Koro, Ovalau, Ngau, and Kandavu, although these forests appear much less diverse in composition than those of the two large islands. I have not observed the species at higher elevations than 950 m.; from this point to the crests of ridges and summits of peaks the trees are smaller and frequently gnarled, with more abundant epiphytes and cryptogams. The highest elevation in Fiji is 1323 meters, on the summit of Tomanivi, but several hills on Viti Levu exceed 1000 meters. The highest elevation on Vanua Levu is 1030 meters,

on the summit of Mbatini. Conditions of exposure in the Vanua Levu hills seem to be such that the truly montane forest reaches lower elevations than it does on Viti Levu, and consequently *Degeneria* is not anticipated above 700 or 800 meters on Vanua Levu.

HABIT

Seedlings which could be positively assigned to *Degeneria* were not observed by me personally, but fortunately those collected in Naitasiri, mentioned above, are available for study; their salient features are discussed by Dr. Swamy in the following paper.

The juvenile plant is a slender treelet with a spreading crown and very large leaves. Although the petioles of these leaves are no longer than some observed on mature trees, the blades are conspicuously larger, attaining a size of $25-45 \times 10-14$ cm. They are sometimes gradually attenuate to the base and long-decurrent on the petiole, while the apex may be deltoid-cuspidate and as much as 1 cm. long, a character not observed in mature leaf-blades, which seem always to be either rounded or lightly emarginate at the apex. The juvenile leaf-blades sometimes have as many as 30 pairs of principal secondary nerves, whereas those of mature plants seldom have more than 18 such pairs.

The mature tree, like most species of the Fijian rain-forest, is extremely slender for its height, with a freely branching crown and dense foliage. At apparently maximum growth it may be from 18 to 30 meters high, at which stage its trunk has a breast-high diameter of only 45-70 cm. Characteristically the trunk has 3-7 fairly obvious rounded buttresses, these being usually apparent upward for about one or rarely for two meters. The individual portrayed in PL. 1, fig. A, is only half-grown and does not have the buttresses well developed. The bark is dark gray and comparatively thick, with rather regular fissures.

Apparently our two original collections were diverse enough to cover essentially all the dimensional foliar variation now known. It may be repeated that the leaf-blades of mature trees are extremely variable in size, sometimes only 5×2.5 cm. (our original dimensions having been $9-27 \times 3.5-13.5$ cm.). The principal secondary nerves may be as few as 8 per side (originally stated as 10-18).

Some specimens of *Degeneria* observed in 1947 were spectacularly loaded with flowers, but, as mentioned above, the effect of this prolific flowering is lost in the forest-canopy. Fully open flowers are sometimes 5 cm. in diameter, but they disintegrate and lose their petals very quickly. At anthesis they emit a pleasing fragrance suggestive of that of some anno-naceous flowers, e.g. *Cananga odorata*.

Dissection of preserved flowers and fruits by Dr. Swamy permits the following emendation of the original description. The sepals are very rarely 4 in number, although 3 is certainly the characteristic number. The petals (originally mentioned as 12 or 13 in number) are seen to be occasionally as many as 18; they are arranged in 3-5 series, and the

maximum size now observed is 24×14.5 mm. (originally stated as 19×12 mm.). The stamens may be 20–30 in number and 3- or 4-seriate; the largest ones observed are 9.5×2.5 mm. (originally stated as 6×2.5 mm.), with thecae up to 5 mm. long. The staminodes are 10–13 in number (rather than 11 or 12) and up to 7×3.5 mm. in size. The carpel is practically always single, as previously stated. However, in one dissection Dr. Swamy found two carpels in a flower, and one of my herbarium specimens (no. 5555) shows a single instance of two developing fruits. The number of ovules varies considerably beyond the 24 or 26 mentioned originally, being as now observed 20–32, although the extreme numbers are rare. The fruiting pedicel sometimes attains a length of 5 cm. The mature fruit has not previously been described. The most advanced fruits seen by me were still attached to the branchlets, but they occur far back from the growing point, on a portion from which leaves have fallen. Sometimes the same tree also bears half-developed fruits, which are more distal on the branchlets but still below the flowers. Thus one may observe specimens at full anthesis with flowers associated with the foliage, with half-developed fruits somewhat lower on the branchlets, and with essentially mature fruits still lower. In such cases fruits in an intermediate stage of development were not found, and this may incline one to suppose that two seasons (but not necessarily two calendar years) are needed for fruits to reach maturity. When essentially mature and apparently ready to fall from the tree, the fruits are rich pink to purple in color, falcate-oblong-ellipsoid in shape, and up to $10.5 \times 4.5 \times 4.5$ cm. in size. I did not observe dehiscent fruits attached to the tree, but some which I dislodged were later observed, on the forest-floor, to have dehiscent along the ventral suture. The elaborate vascular skeletons of decayed fruits were sometimes found, and these were always wide open along the ventral margin. Hence we feel sure that our original mention of the fruit as indehiscent is inaccurate. The pericarp, except for its hard outer layer, is very thick and fleshy, becoming greatly shriveled in drying. The “waxy irregularly lobed appendages” which we originally described and figured as arising from the endocarp are actually merely irregular remnants of the carpellary wall. Most of the ovules appear to develop, but only rarely are as many as 32 seeds to be found in a fruit. The fresh seeds are up to 16 mm. long and 12 mm. broad; their outer coat is thick, smooth, waxy, and bright orange-red in color.

HABITAT

Degeneria vitiensis is among the largest trees of the Fijian rain-forest. It has been observed on flat land as well as on extremely steep hillsides, on well-drained soil in undisturbed forest. The Fijian forest reaches its best development under very equable climatic conditions, as demonstrated by Tables 1 and 2, in which temperature and rainfall statistics are given for a few selected localities in the forested portions of the two large islands. The annual variation in temperature is comparatively slight, and alti-

TABLE 1

Temperature statistics of selected localities in Fiji, from records
of Meteorological Department, Suva

PLACE, PROVINCE, ISLAND	NO. YEARS COVERED BY RECORD	MEAN TEMPERATURE ° F.	ABSOLUTE MAXIMUM ° F. AND MONTH	ABSOLUTE MINIMUM ° F. AND MONTH
Suva, Rewa, Viti Levu	56	77.1	98 March	55 July
Nandarivatu, Mba, Viti Levu	5	68.3	85 February March	45 July

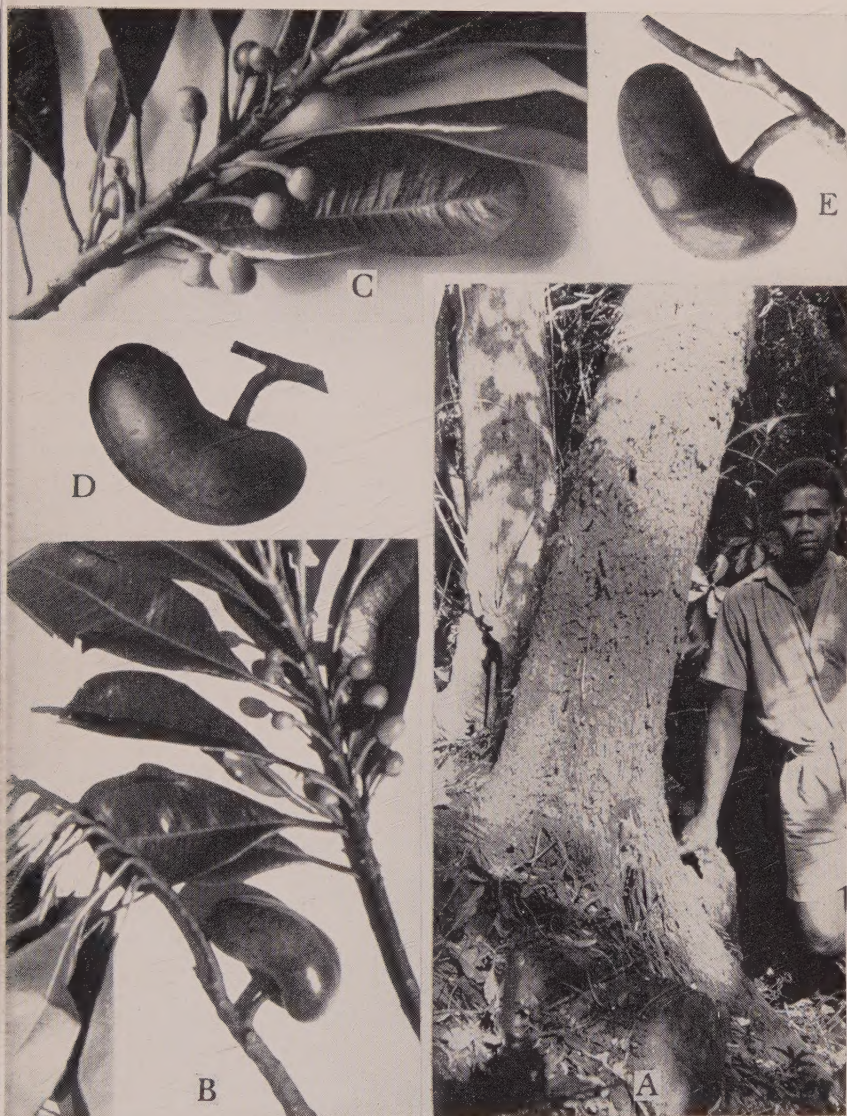
TABLE 2

Rainfall statistics of selected localities in Fiji, from records
of Meteorological Department, Suva

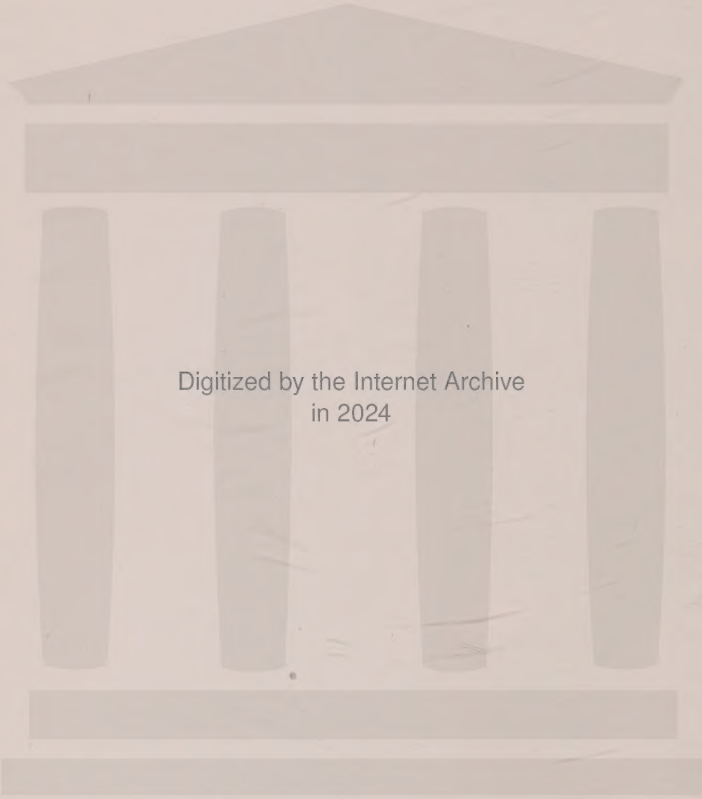
PLACE, PROVINCE, ISLAND	NO. YEARS COVERED BY RECORD	NORMAL ANNUAL RAINFALL (INCHES)	NORMAL NUMBER OF WET DAYS	NORMAL RAINFALL (INCHES), WETTEST MONTH	NORMAL RAINFALL (INCHES), DRIEST MONTH
Suva, Rewa, Viti Levu	51-57	120.86	246.8	14.73 March	5.41 July
Nasinu, Naitasiri, Viti Levu	11-15	129.51	220.5	16.95 April	4.98 June
Vunindawa, Naitasiri, Viti Levu	20-33	140.10	175.6	17.16 December	4.14 July
Nandarivatu, Mba, Viti Levu	19-45	137.63	176.3	25.06 February	3.56 July
Wainunu, Mbua, Vanua Levu	20-66	146.46	199.0	18.23 January	5.64 July
Yanawai, Mbua, Vanua Levu	8	202.34	237.0	22.01 May	13.14 June
Salialevu, Thakaundrove, Vanua Levu	11-25	213.57	183.5	20.99 October	13.63 July

tudes up to 800 m., that of Nandarivatu, produce an average fall in temperature of only 10°F. as compared with localities at sea-level. Rainfall is well distributed throughout the year in the forested areas of Fiji, and even in the driest months four or more inches of rain may be expected. For permission to reproduce these statistics I am greatly indebted to Mr. Ralph Dyer, Director of the Meteorological Department in Suva.

The forest inhabited by *Degeneria* cannot adequately be characterized by mention of any single species or any small group of species; it is greatly diversified, although sometimes locally dominated by the *ndakua* (*Agathis vitiensis*), conspicuous by its comparative great size. The more frequently observed components of this forest, as seen in north-central Viti Levu, may be mentioned as follows:



DEGENERIA VITIENSIS Bailey & Smith



Digitized by the Internet Archive
in 2024

LARGE UPPER STOREY TREES (approaching or exceeding 30 meters in height): *Agathis vitiensis* (common), *Podocarpus vitiensis* (common), *Dacrydium* sp. (frequent, no. 6244 ⁴), *Ficus obliqua*, *Hernandia olivacea*, *Endospermum macrophyllum*, *Canarium vitiense*, *Garcinia pseudoguttifera*, *Calophyllum vitiense*, *Elaeocarpus* spp. (e.g. no. 5954), Sapotaceae spp. (e.g. no. 6195).

TREES OF MEDIUM HEIGHT: *Podocarpus* sp. (*asimbolo*, an important timber tree), *Gironniera celtidifolia* (often abundant), Lauraceae spp. (*Cinnamomum*, *Cryptocarya*, *Endiandra*), *Myristica castaneaefolia*, *Xylopia* no. 5868 and other Annonaceae, *Elaeocarpus* spp. (e.g. no. 6189).

UNDERSTOREY TREES: *Gnetum Gnemon*, *Aglaia* spp., *Schefflera vitiensis*, *Discocalyx* spp., *Diospyros* spp., *Couthovia collina*, numerous Rubiaceae, including *Psychotria* spp., *Airosperma trichotomum*, *Readea membranacea*, and *Mastixiodendron flavidum*.

SHRUBS: *Piper* spp., *Elatostema Archboldianum* and *E.* no. 5976, *Cyrtandra* spp., *Psychotria* spp.

VINES: *Epipremnum pinnatum*, *Piper insectifugum*, *Agatea violaris*, *Medinilla* spp., *Strychnos vitiensis*.

This type of rain-forest abounds in ferns, both terrestrial and epiphytic, but lower cryptogams are comparatively few, reaching their greatest profusion at higher elevations or on exposed ridges where the above components are generally not found.

EXPLANATION OF THE PLATE

Degeneria vitiensis I. W. Bailey & A. C. Smith. Fig. A. Trunk of medium-sized tree. Fig. B. Flowering and fruiting branchlets, showing position of essentially mature fruit below the leaves, $\times 1/5$. Fig. C. Flowering branchlet, with nearly mature flowers, $\times 1/3$. Fig. D. Essentially mature fruit, showing line of ventral suture, $\times 1/3$. Fig. E. Lateral view of essentially mature fruit, $\times 1/3$. Fig. A from *Smith 6301*; Figs. B-E from *Smith 5880*.

DEPARTMENT OF BOTANY,

U. S. NATIONAL MUSEUM,

SMITHSONIAN INSTITUTION.

⁴ In these lists a few species which have not yet been identified are referred to by my field-numbers.

FURTHER CONTRIBUTIONS TO THE MORPHOLOGY OF THE DEGENERIACEAE

B. G. L. SWAMY

With four plates and thirteen text-figures

DURING HIS COLLECTING TRIP in the Fiji Islands in 1947,¹ Dr. A. C. Smith was able to pickle valuable material of *Degeneria vitiensis* I. W. Bailey & A. C. Sm. This material includes not only leaves, nodes, shoot apices, seedlings, etc., but also flowers and fruits in almost all stages of development. Although most of the material was fixed in formalin-acetic-alcohol, limitation of resources in one case forced Dr. Smith to substitute "gin" when he secured important developmental stages of the gametophytes. However, the gin-fixed material has fortunately rendered itself suitable for interpretation, although the slides may not satisfy all the requirements of technical perfection. The material on hand has made possible not only a verification of the original findings of Bailey and Smith (1), but also new observations on the gametophytic and post-fertilization development, vascularization of the flower, seedling structure, etc. I sincerely thank Dr. Smith for placing the material at my disposal and thereby providing me with the opportunity of studying it. I cannot adequately express my gratitude and appreciation to Prof. I. W. Bailey for his unfailing encouragement and illuminating suggestions during this study and also for his assistance in the preparation of photomicrographs.

SECONDARY XYLEM

There is not much to be added to the anatomical characteristics of the secondary xylem, which have already been described by Bailey and Smith (1). However, the following points as revealed by the peripheral regions of a large stem measuring about 60 cm. in diameter (#5880),² may be noted. In the inner regions of the secondary xylem, the multi-seriate rays are predominantly 3-4-seriate, fairly high, usually with one to three upright cells at either end as seen in tangential sections; the uniseriate rays are infrequent, shorter than the multiseriates and composed of upright cells. In the outermost region of this old specimen, the multiseriate rays become predominantly 4-5-seriate, shorter and without any upright cells at the margins. Uniseriate rays are eliminated. The narrow bands of apotracheal parenchyma are distributed throughout the secondary xylem. This situation is in contrast to the secondary xylem of the magnoliaceous genera of the north temperate climate, where the parenchyma is confined to the outer face of the growth rings.

¹ See the preceding article in this journal.

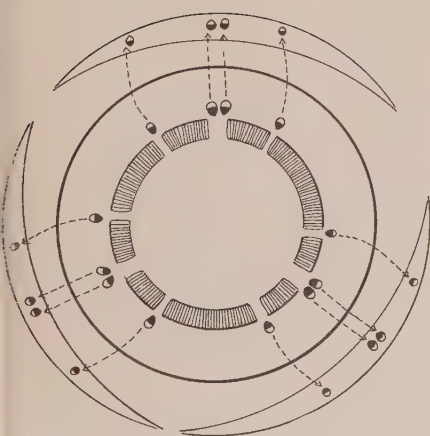
² In the few instances where it has seemed advisable to refer to a specific collection, the number indicates Dr. Smith's field-number. For locality, etc., see the preceding paper in this journal.

SEEDLING

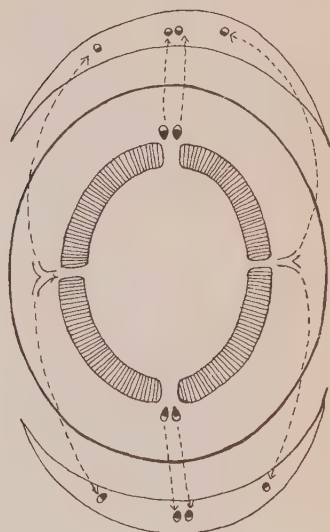
Four seedlings of *Degeneria* were available for examination and all of them possess three cotyledons. The whorl of thin, palmately veined cotyledons is preceded by a long hypocotyl, 6–10 cm. The first leaf is characteristically emarginate, pinnately veined, and more nearly elliptic in



1a



1



2

FIGS. 1–2. Fig. 1. Diagram showing the vascular pattern of the cotyledonary node of *Degeneria*. Fig. 1a. Diagram to show the pattern of vascularization in the cotyledon, $\times 5$. Fig. 2. Diagram showing the vascular pattern of the cotyledonary node in *Magnolia grandiflora*.

outline. The subsequent leaves soon assume the elliptic to obovate-elliptic norm of the genus.

Two median vascular traces originating from a single gap in the stele enter each cotyledon. These strands remain distinct in the petiole, *Figs. 1, 1a*, but unite in the basal part of the lamina into a single strand which then forms the median vein of the cotyledon. The phloem of the strand maintains its doubleness till about half the distance in the cotyledon and then unites. The marginal traces of the cotyledons arise from separate gaps in the stele, *Fig. 1*, and bifurcate in the basal part of the lamina, *Fig. 1a*; the bifurcated strands diverge in the blade in a palmate fashion. The branches of these lateral strands vascularize most of the lower half of the blade. The remainder of the cotyledon is vascularized by the branch system of the median strand, *Fig. 1a*.

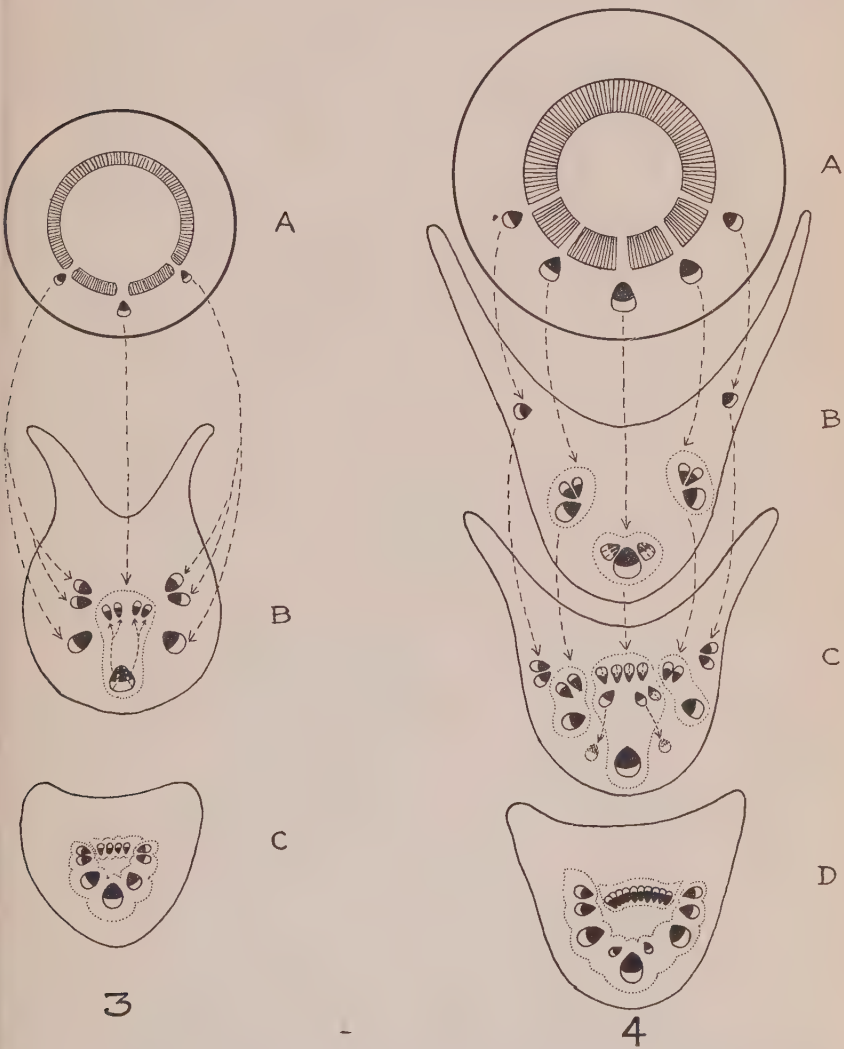
The seedlings of the Magnoliaceae (*Magnolia*, *Michelia*, *Liriodendron*) are provided with two cotyledons in the great majority of cases, *Fig. 2*. The median pair of strands originates in the same manner as in *Degeneria*, but the four lateral strands of the two cotyledons are derived by the bifurcation of two traces which arise from two gaps in the stele. Even in those abnormal instances of tricotyledonous seedlings which are now and then encountered in *Magnolia stellata*, the lateral traces of the adjacently placed cotyledons arise in the same way. This pattern seems to be stabilized fairly well in the family, although *Magnolia Soulangeana* (7) appears to possess a nodal anatomy similar to *Degeneria*.

ANATOMY OF THE NODE AND PETIOLE

The first few leaves of the seedling receive three traces from a corresponding number of gaps in the stele, *Fig. 3A*, and thus the nodes on which these leaves are borne are trilacunar. In serially arranged transverse sections of the petiole, the three traces exhibit the following changes in their courses outward into the leaf. The median trace trifurcates, forming a large central strand and two smaller lateral ones. The lateral strands, from a purely descriptive point of view, appear to shift adaxially toward the upper part of the petiole and split into four small bundles having an inverted orientation of xylem and phloem, *Fig. 3B*. The lateral traces (compare *Figs. 3A* and *3B*) bifurcate, and the more adaxially situated products of this division subsequently divide, forming a total of six strands, three on each side of the derivatives of the median trace. Higher in the petiole, the large abaxial segment of the median trace and the branches of the lateral traces converge in the form of a large arc of seven strands, *Fig. 3C*. This arc is closed by the four smaller derivative strands of the median trace, thus giving rise to an adaxially flattened eustele.

In contrast to the seedling nodes, those on the mature stem are pentalacunar, *Fig. 4A*, as reported by Bailey and Smith (1), although very large leaves of vigorously growing saplings may receive more than five bundles from the corresponding nodes. With increase in the number of traces the vascularization pattern of the petiole becomes more complex. The median trace trifurcates at the base of the petiole, *Fig. 4B*, the lateral

segments of which break up into a varying number of eight to twelve strands. These smaller strands aggregate in the upper part of the petiole, the individual strands orienting to form a loose "inner eustele," *Fig. 4C*. The second pair of laterals also divide. At a higher level, two to four strands from the "inner eustele" swing back into an abaxial position on either side of the median trace, as indicated by broken arrows in *Fig. 4C*. The paired adaxial segments of the first pair of laterals join the corre-

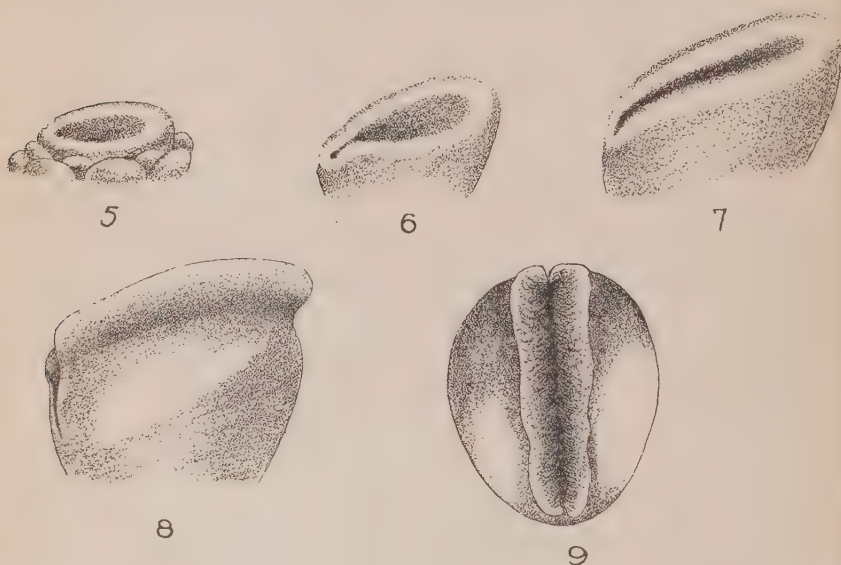


FIGS. 3, 4. *Fig. 3.* Series of diagrams illustrating the behavior of the vascular traces at the node and in the petiole of a seedling leaf. A represents the nodal level; B and C, basal and upper levels of the petiole. *Fig. 4.* Same; in the adult leaf. A represents the nodal level; B, C, and D, successively higher levels in the petiole.

sponding ends of the now more or less opened "inner eustele" in the form of a strap, which occupies the flattened upper side of the petiole. The remainder of the traces unite into a large horse-shoe-shaped arc, the ends of which approximate the lateral extremities of the strap-shaped segment, thus forming an adaxially flattened eustele, *Fig. 4D*. In spite of these complications, the fundamental pattern — trifurcation of the median trace and the organization of the adaxial strap-shaped segment largely by the lateral segments of the median trace — is the same in both the seedling and the adult leaves. In the latter, the number of bundles involved is decidedly larger and a few of the strands of the median system swing back into an abaxial position, which situation has no counterpart in the trilacunar seedling leaves.

ORGANOGENY

The first structures to develop on the thalamus are the calyx members. The differentiation of the petals takes place in quick succession, the outermost members originating first, *Fig. 82*. There seems to be a time lag before the initiation of the androecium, during which period the corolla completely envelops the broad, mound-shaped floral apex, *Fig. 83*. The ontogenetic differentiation of the staminal whorls is also in a centripetal



FIGS. 5-9. Stages in the development of the carpel.

succession. Some of the last-formed members of the androecium later transform themselves into staminodes. After the initiation of the androecium, *Fig. 84*, the floral apex is rendered narrower and somewhat blunt. This apex is used up in the organization of the solitary carpel, *Fig. 85*. Thus the order of development of calyx, corolla, androecium and gynoecium, as well as of the individual whorls of corolla and androecium, is in centripetal succession.

As a result of the confinement of meristematic activity to the rim of the carpel primordium, an embossed periphery is created. At this stage, the primordium appears as a shallow cup, having an outline similar to that of a horse-shoe, the free ends of which are fused, *Fig. 5*. A few cells on this ventral side fail to divide but the surrounding cells continue divisions; as a result, a notch appears in the wall of the cup, *Fig. 6*. Furthermore, the cells of the rim on the dorsal side maintain a faster rate of division and the tissue on this side grows rapidly in height. This results in a conduplicate structure enclosing a cavity between the folds. The structure itself is abaxially deformed, *Fig. 7*. The free edges grow out externally in the form of flanges, whose margins flare apart, *Figs. 8, 9*. A transverse section of the carpel at this stage is represented in *Fig. 89*. The internal surfaces of the flanges later become stigmatic, as will be described on a subsequent page.

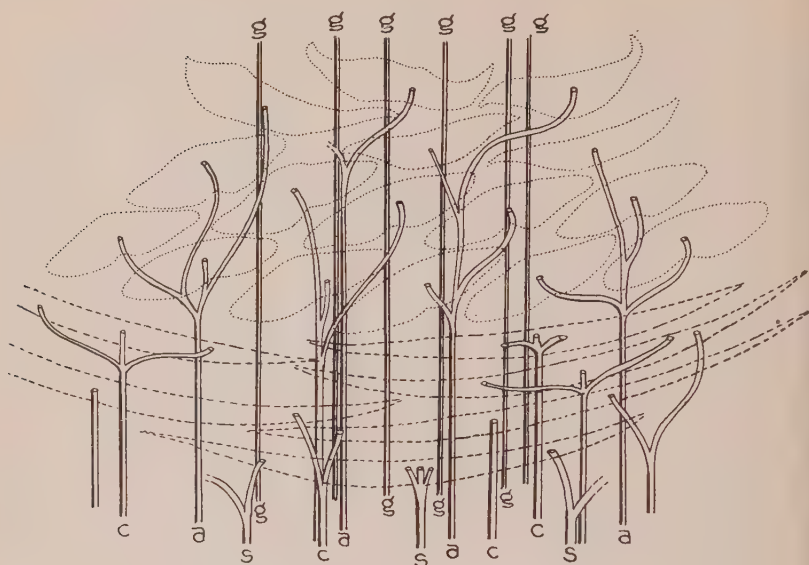
VASCULARIZATION OF THE FLOWER

An ontogenetic outlook in studies dealing with the vascular anatomy of flowers is an essential factor for an understanding of the real significance of the phenomena involved. The procambial system laid down during the early development is subject to a high degree of modification as the flower attains maturity. The modifications involve either an elaboration of the system which brings greater complexities into the adult vascular structure, or a reduction whereby the mature vasculature becomes very much simplified. In order to emphasize the degree and nature of the complications that attend the procambial pattern of the *Degeneria* flower, the topic will be considered at present under two heads — the procambial pattern and the vascular pattern at anthesis. The adaptation of this method should not be interpreted as implying that all the organs of the flower have their vasculature represented only by the procambial strands at any one single step and that the strands become differentiated into xylem and phloem at another single step. In fact, hand in hand with the extension of the procambial strands into the newly formed structures on the floral axis, the older portions of the same strands become transformed into xylem and phloem. This being the case, it would be misleading to look at the phenomenon as involving two definite steps. The distinction made at present is only for the sake of description.

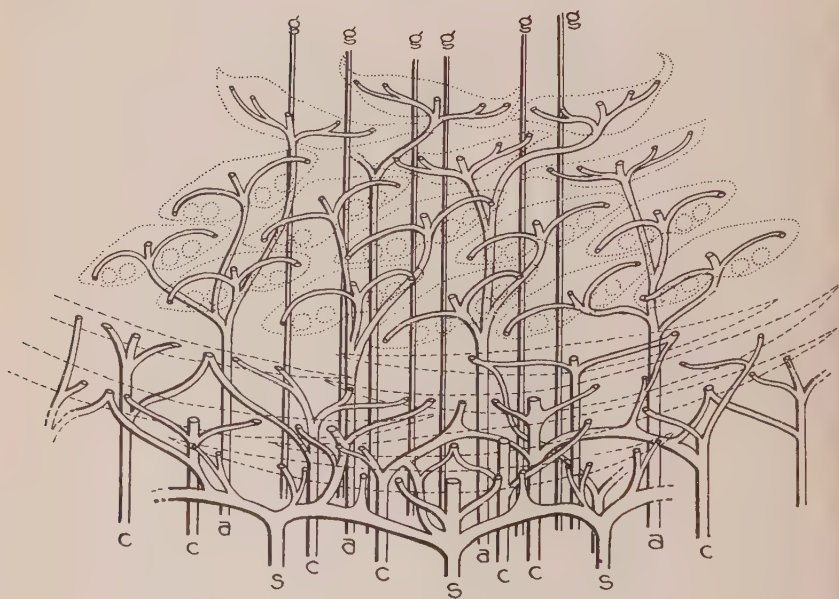
Procambial pattern:

Figure 10 represents what may be called the "procambial diagram" of a sector of the flower. This diagram is synthesized after following the course of differentiation and extension of the procambium into the respective structures of the flower as they are being formed on the thalamus; the secondary modifications of these strands have been deliberately omitted in this figure, but have been incorporated in the diagram representing the vascular pattern at anthesis, *Fig. 11*.

In general, the method of supply of the procambial strands to the sepals and petals is very similar. Each member receives a median and two mar-



10



11

FIGS. 10, 11. *Fig. 10.* Procambial diagram of a sector of a flower, depicted as seen from the side with one of the calyx lobes facing the reader. *s*—vascular traces supplying the sepal members; *c*—of petal members; *a*—of androecial members; *g*—of gynoecium. *Fig. 11.* Vascular diagram of the same sector at anthesis. Lettering as in Fig. 10.

ginal traces, *Fig. 10* (traces of the sepals marked *s*, of the corolla, *c*). The marginal traces of the adjacently placed members are usually derived from a common stelar bundle. However, each of the petals belonging to the innermost whorl receives a single bundle, which trifurcates into median and marginal traces. Each member of the androecium receives a single trace. It may be noted that the supply of a group of four or five stamens originates from a single stelar bundle (marked *a*). The remainder of the procambial bundles (marked *g*) fuse with each other into seven to nine larger units before entering the carpel.

Vascular pattern at anthesis:

By the time the flower bud attains the stage of anthesis, the simple pattern of vascularization just described becomes highly modified, of course, retaining the original ground plan in all essentials (compare *Figs. 10* and *11*; the latter diagram represents the same sector of the flower as that depicted in the former). The important modifications that are involved may be briefly stated as follows.

PERIANTH.—The vasculature of the perianth members is subject to a high degree of modification. The median and marginal traces of each member branch, and the branches anastomose not only with one another but also with similar branches belonging to the members of the adjacent whorls. Numerous new traces originate from the points of anastomoses and occupy positions on either side of the median and marginal traces of each perianth lobe.

ANDROECIUM.—In the androecial members, the modification is less pronounced. The single vein trifurcates into the median and marginal traces at the very base of the microsporophyll. In the staminodes, the marginal traces undergo a further bifurcation at the base and are generally more highly developed than in the stamens.

In this connection some points in the ontogeny of the stamens and staminodes may be considered. The primordia of all the individual members of the androecium are alike in shape, size and histological characteristics. The cells are richly protoplasmic and show a great and uniform avidity for stains. With subsequent development, parenchymatization starts in the adaxially situated cells and proceeds in an abaxial direction. When this phenomenon advances to about half the distance between the abaxial and adaxial surfaces, a nest of small cells in the center becomes differentiated as the procambial strand. It is at about this time that the archesporial cells begin to differentiate in the hypodermal layer on the abaxial side. The archesporial cells undergo the first periclinal division, leading to the formation of the primary parietal and sporogenous layers. The development until this stage is characteristically seen to take place in all the primordia of the androecium, irrespective of their destination, whether staminal or staminodal.

From this stage onwards, in those primordia that belong to the innermost whorl and in a varying number of primordia that belong to the next outer whorl, the subsequent development of the sporogenous tissue be-

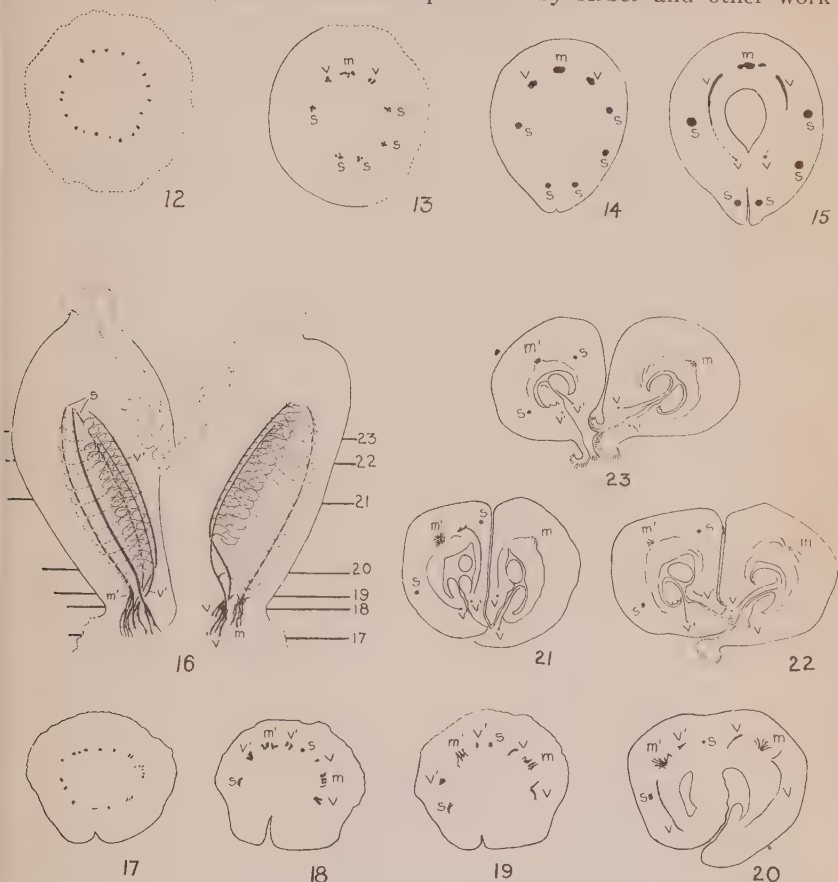
comes arrested and all the cells excepting the procambial strand become rapidly parenchymatized. By further differentiation of the component cells and by a modification of the external form, the appendages become staminodes. On the other hand, the development of the sporogenous tissue continues in the remaining primordia and the rate of parenchymatization of the cells becomes somewhat retarded, so that an abaxial patch of darkly staining cell layers still persists (compare the staminodes and the stamens in *Fig. 85*). These appendages mature into stamens.

Thus it will be seen that both the staminodes and stamens show a fundamentally similar origin and development until a certain stage, and the factors that make them develop into one or the other of these structures operate later; both structures are similar in their method of vascularization, although the marginal traces in the staminode divide once again. Furthermore, the stamens may often bear degenerate sporangia (1). All of these facts indicate that in *Degeneria*, the staminodes are best interpreted as sterile microsporophylls.

GYNOECIUM. — The gynoecium of *Degeneria* is represented by a solitary carpel occupying a terminal position on the floral axis. After supplying the members of the preceding whorls, a fairly large number of cauline bundles (varying usually between 18 and 25) are left over in the floral axis, *Fig. 12*. A few of these bundles, however, disappear at the base of the carpel; others recombine into seven to nine larger bundles, *Figs. 13, 14*. The three adjacently placed bundles (marked *m* and *v* in the figures) situated below the midrib region of the folded megasporophyll run into it as median and ventral traces; the other bundles (marked *s*) also enter the carpel and occupy positions in its wall as indicated in the illustrations, *Fig. 15*. The median trace gives out extensive side branches, which spread in the carpellary walls in a pinnate manner, *Figs. 24-27*. The ends of the branches finally anastomose with the ventral trace of the corresponding side. The branches of the ventral traces and to a small extent those of the dorsal trace take part in the vascularization of the ovules, as will be explained in a later paragraph. In contrast to the behavior of the ventral and median traces, the extra traces (marked *s*) in the carpel remain distinct and isolated — in location as well as in the degree of branching — from the system of the median and ventral traces. Even in the mature fruit, they persist as robust cords, maintaining the same configuration, *Fig. 29*. In other words, in spite of the fact that several traces enter the carpel, only three of them (the median and ventrals) behave as normal carpellary traces, whereas the others do not; the presence and behavior of the median and ventral traces in the carpel is typical and consistent, whereas the number of the extra traces is subject to fluctuation. This situation leads one to suspect strongly that the extra traces do not belong to the integral vascular system of the carpel and to conclude that the carpel of *Degeneria* is essentially a three-trace megasporophyll as in the Winteraceae(2).

How then can the extra traces of the carpel be explained? What may be their possible significance? In this connection it is worth while to

recall the general behavior of floral apices in relation to vasculature. Unfortunately such studies have not been extended to a wide range of flowers. However, the information provided by Arber and other work-



FIGS. 12-23. Figs. 12-15. Transverse sections at successive levels starting from the base of the carpel. Explanation in text. Fig. 16. Semidiagrammatized pattern of vascularization in a two-carpelled gynoecium as seen from a side; reconstructed after a study of serial transverse sections. Figs. 17-23. Transverse sections of the two-carpelled gynoecium at levels indicated in Fig. 16 by corresponding numbers. All figs., $\times 10$.

ers³ is indicative of the following salient generalizations: In multi-carpellate flowers the vascular bundles of the axis that are left over after supplying the perianth and androecium take part in the vascularization of the carpels in a normal and uniform manner. Thus all vascular bundles are "used up" by the carpels. This seems to be the usual behavior in the great majority of instances. But, particularly in genera

³ See Arber, A. "The interpretation of the flower: A study of some aspects of morphological thought," Biol. Rev. 12: 157-184. 1937, and literature cited therein.

and species that exhibit a series in the reduction of many carpels to one, the following modifications are frequently seen, either singly or in various combinations. (i) The vascular bundles (residual vascular tissue) that would have supplied the missing carpel or carpels may still persist in the floral axis either as such or after anastomosing with one another in various ways. (ii) The residual bundles may disappear at a considerable distance below the persisting carpel or carpels. (iii) They may fuse with the bundles that are concerned in supplying the persisting carpel or carpels. (iv) They may enter the persisting carpel itself as supernumerary traces.

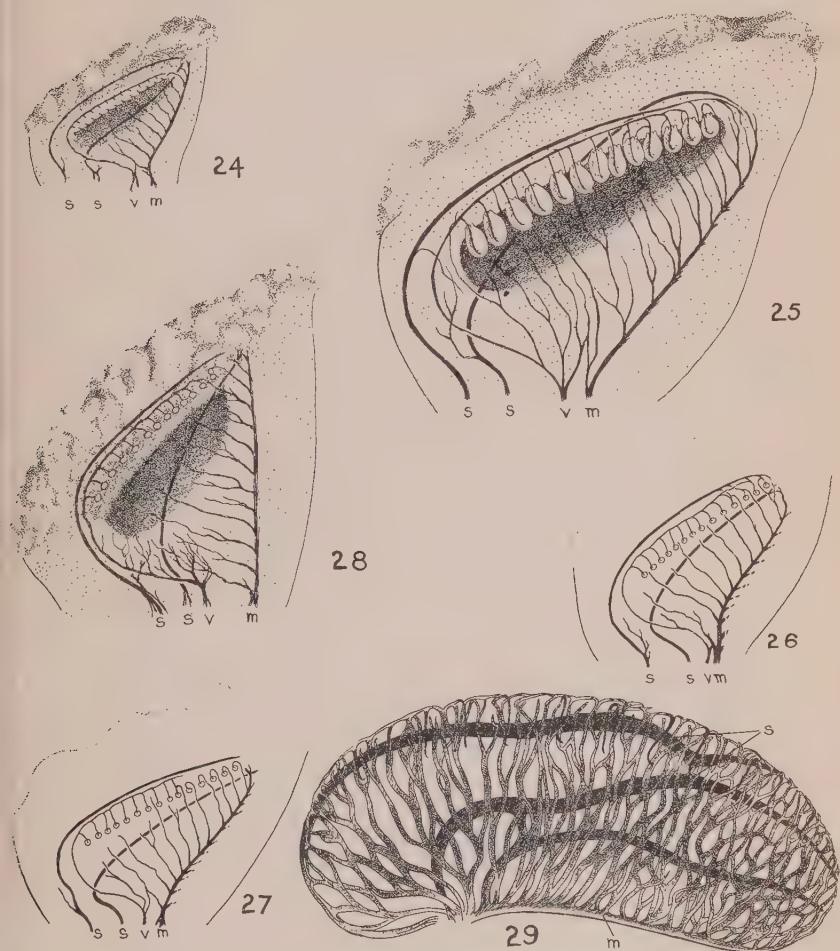
The situation in *Degeneria* seems to be a combination of the factors involved in items (i) and (iv). It may now be recalled that in *Degeneria* a large number of the stelar bundles are left over in the floral axis at the base of the carpel; that these fuse with one another into seven to nine larger bundles; that three of them form the median and ventral traces of the carpel; that the other extra bundles also enter the carpel and travel throughout its entire length; and that the behavior of the extra bundles within the carpel is markedly different from that of the median and ventral traces. The extra bundles therefore probably represent those that formerly supplied other carpels. In other words, the ancestral flower of *Degeneria* was in all probability multicarpellate. That this was most likely the actual condition is further supported by the method of vasculature of a bicarpellate flower.

Very rarely, flowers of *Degeneria* bear two carpels, attached at slightly different levels on the thalamus, *Figs.* 16–23. A transverse section just below the level of attachment of the carpels, *Fig.* 17, shows the bundles of the axis arranged in a ring in the same manner as in a monocarpellate flower, compare *Fig.* 12. The bundles unite in various ways with one another resulting in eight larger bundles, *Fig.* 18. The three bundles disposed towards the right hand side (marked *m*, *v*) supply the median and ventral traces to the first carpel. Of the remaining five bundles, the middle three (marked *m'*, *v'*) form the median and ventral traces of the second carpel; the other two bundles (marked *s*) also enter the upper carpel as supernumerary traces and behave in the same manner as in the case of the normal monocarpellate flower, that is, remain distinct from the integral vascular system of the carpel.

Two significant points emerge from this data. (i) The first carpel on the axis does not present any anomalies in its vascularization. (ii) The ultimate carpel receives only two extra traces in contrast to the monocarpellate gynoecium of the normal flower, where the number of such traces is larger, four to six. In other words, with more numerous carpels on the floral axis, the number of extra traces in the ultimate carpel becomes reduced and probably eliminated. Conversely, the presence of supernumerary traces in the normal monocarpellate flowers of *Degeneria* is closely associated with the phylogenetic reduction in the number of carpels.

VASCULARIZATION OF THE OVULES. — At the very base of the carpel, the ventral trace gives off two or three side branches which further ramify

and anastomose with the system of the median trace, *Figs. 24–27*. The remainder of the trace continues to run along the ovule-bearing region. In general, this trace remains relatively weakly developed and on this account there is every possibility of overlooking its presence and at the



FIGS. 24–29. All figures are shown as if a carpel were halved along the plane of conduplication with the split surface facing the reader. *m* — median trace; *v* — ventral trace; *s* — supernumerary trace. *Fig. 24*. Vascularization of the carpel at the time of origin of ovular primordia, $\times 25$. *Fig. 25*. Same, at anthesis, $\times 25$. *Figs. 26 and 27*. Variations in the vascularization of the ovules at anthesis. Small circles denote the funicles with the ovules removed. Semidiagrammatic, $\times 17$. *Fig. 28*. Drawing to show the expanse of the papillate stigmatic surface at anthesis; note its extension towards the interior of the carpel beyond the ovule-bearing region; ovules are removed and their respective places of attachment are denoted as empty circles, $\times 20$. Also compare *figs. 52 and 87*. *Fig. 29*. Vasculature of mature fruit, $\times 2.5$.

same time mistaking the otherwise well developed supernumerary trace, as in *Figs. 24-27, 41-44*, for the ventral.

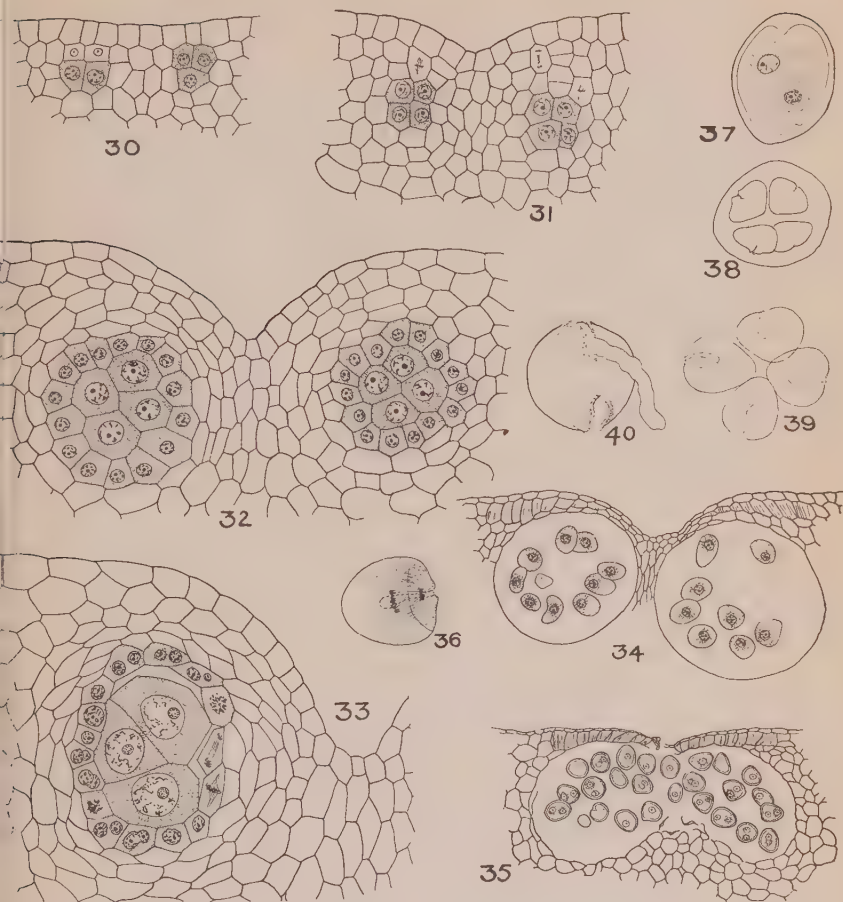
The ventral trace is concerned with the vascularization of the majority of the ovules. It sends out a number of slender branches all along its length and each branch enters an ovule. This pattern is stabilized in the ovules that are situated towards the basal region of the carpel. On the other hand, some of the ovules that are situated especially towards the distal end exhibit an altogether different situation. It has been pointed out that the median trace of the carpel builds up an extensive branch system and that the branches reach towards the ventral traces with which they ultimately fuse. Frequently, some of the branches of the median system fuse with the ovular traces given out by the ventrals (see the penultimate ovules towards the distal end in *Fig. 25*), whereby such ovules should be considered as having been vascularized by both the median and ventral systems. Less frequently the ventral trace is precociously used up and the distally situated ovules derive their vascular supply only from the median system, *Fig. 27*. In very rare instances, the supernumerary traces may also send out one or two slender branches that fuse with those of the distally situated ovular traces, *Fig. 26*. These various methods of vascularization often occur in the same carpel in varying combinations and fluctuate from carpel to carpel.

MICROSPORANGIUM AND MICROSPORES

As pointed out by Bailey and Smith (1), the microsporangia are immersed beneath the abaxial surface of the sporophyll. As already mentioned on a previous page of the present contribution, the primary archesporium differentiates in the hypodermal layer of the abaxial surface. This fact negates any suggestions that the extrorse dehiscence in *Degeneria* is due to an ontogenetic shift in the position of the sporangia.

Although the primary archesporial cells are strictly hypodermal in origin, occasionally one or two cells belonging to the sub-hypodermal layer also show the characteristics of archesporial cells (group of three cells in the right side of *Fig. 30*). It is quite possible that the cells of the sub-hypodermal layer may infrequently become a part of the archesporium and share its subsequent development. Two adjacent groups of archesporial cells, each group consisting of two or three cells as seen in transverse sections, are differentiated between the median and marginal traces of the sporophyll. The first division in the archesporium results in the formation of parietal and sporogenous layers, *Fig. 30*. The parietal layer by further periclinal divisions builds up four or five wall layers and the tapetum, whereby the sporogenous cells become deep-seated in the tissue of the sporophyll, *Fig. 31*. The outermost of the wall layers later transforms into the endothecium. The sporogenous cells also may divide once and thus increase in number before differentiating as microspore mother cells.

Simultaneously with their enlargement, the microspore mother cells become jacketed by a continuous layer of tapetum, *Fig. 32*. When the



FIGS. 30-40. *Fig. 30.* Two adjacent groups of sporogenous cells of one half of the microsporophyll. In the right group, the archesporium is shown, in the left it has divided into the parietal and sporogenous layers, $\times 200$. *Fig. 31.* Same, showing the differentiation of wall layers; the primary sporogenous cells have also divided, $\times 200$. *Fig. 32.* Same, showing the organization of tapetum, $\times 200$. *Fig. 33.* A single sporogenous group with its tapetum, some of the tapetal cells are binucleate and the nuclei in others are in various stages of division or reunion, $\times 200$. *Fig. 34.* Two adjacent sporangia showing the disappearance of the tapetum, uninucleate microspores and the initiation of the endothecial thickening, $\times 50$. *Fig. 35.* Same, at the shedding stage; the pollen grains are two-celled, $\times 50$. *Fig. 36.* Division of the microspore. The broken line indicates the position of the germinal furrow, $\times 200$. *Fig. 37.* Pollen grain at the shedding stage showing the faintly-stained vegetative nucleus and the darkly stained generative cell, $\times 200$. *Fig. 38.* A young tetrad showing the initiation of the furrow on the distal face of each spore, $\times 135$. *Fig. 39.* Pollen grains of a tetrad immediately after separation, showing the well defined furrow, $\times 135$. *Fig. 40.* A germinated pollen grain removed from the papillate surface of a carpel; note the emergence of the tube from the broadened end of the furrow, $\times 200$.

nucleus of the microspore mother cell is in the prophasic stages of the first meiosis, the tapetal cells become binucleate, *Fig. 33*. Frequently some of the nuclei fuse again and occasionally redivide. However, they do not migrate out of their cells and their general behavior is in conformity with the secretory type of tapetal organization. The cells of the tapetum function actively until after the first division of the microspore mother cell and then degenerate.

The microspore mother cell undergoes the meiotic divisions in a simultaneous manner and produces a tetrad of microspores. Usually, the configuration of the latter is tetragonal, *Figs. 38, 39*, rather than tetrahedral. The young microspore, while it is still lodged within the original wall of the mother cell, shows a conspicuous fold on its distal face, *Fig. 38*. At the time of separation of microspores from the tetrad, *Fig. 39*, a narrow groove with slightly broadened extremities takes the place of the distal fold. It is this groove that differentiates as the germinal furrow (colpa) of the mature pollen grain. Thus it is clear that the position of the germinal furrow in the pollen of *Degeneria* is distal.

The uninucleate microspores, *Fig. 34*, soon become scattered in the sporangial cavity. The nucleus of the microspore migrates towards the distal side of the spore and a vacuole develops towards the proximal side. The first division of the spore nucleus is accomplished in this position. The orientation of the spindle during this division is such that the generative cell is always cut off towards the furrow-end of the grain, *Fig. 36*, that is, towards the exterior end of the tetrad. The generative cell, after a time, shifts its position and comes to lie nearer the interior of the grain, *Fig. 37*. The pollen grains are shed in this two-celled condition.

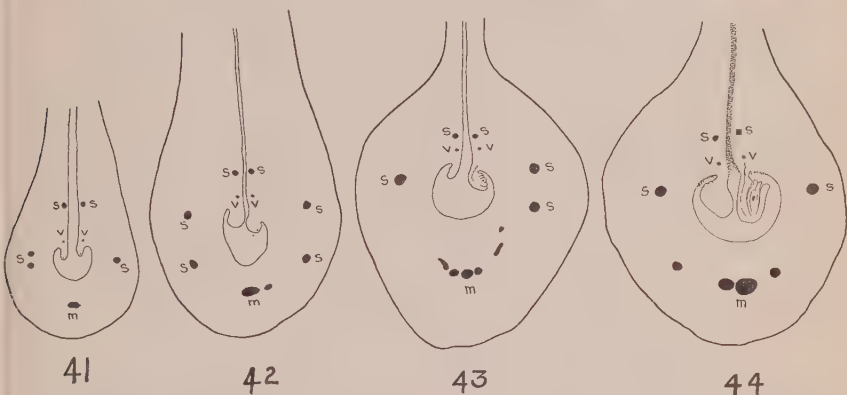
At the time of the division of the microspore nucleus, the cell layers separating the adjacent sporangia break down and their cavities become continuous. The endothecium is characteristically localized in disposition, not extending beyond the outer faces of the sporangia, *Fig. 35*.

MEGASPORANGIUM AND FEMALE GAMETOPHYTE

The ovule-bearing region of the carpel is situated far back of the margins of the conduplicately folded carpel, a feature clearly demonstrated in transverse sections, *Figs. 41-44, 88-91*. Longitudinal sections passing through the plane of conduplication also reveal the same feature, *Fig. 86*, and in addition, reveal the slanting orientation of the carpellary cavity and the ovule-bearing region in conformity with the abaxial deformation of the carpel. A single row of ovular primordia arises opposite each of the ventral bundles, *Figs. 41, 88*. Ten to thirteen primordia constitute a row and the ovule-bearing region itself is confined to the upper end of the carpellary cavity.

The ovular primordia grow into the cavity at first in a vertically downward direction, *Figs. 41, 88*. With the differentiation of the nucellus and integuments, the apex of the ovule undergoes a curvature of 90° , *Figs. 42, 43*, and by the time of sporogenesis, becomes bent on itself, thereby assuming a completely anatropous position, *Figs. 44, 91*.

Soon after the differentiation of the archesporial cell in the nucellus, the two integuments originate more or less simultaneously, *Fig. 47*. When the megaspore mother cell is fully differentiated, the inner integument comes to have three layers of cells and the outer, four to five layers. The number of cell layers in the integuments continue to increase and at the time of fertilization the inner integument consists of four cell layers at the region of the micropyle, but remains three layered in the part sur-



FIGS. 41-44. Transverse sections of carpels at different stages of development to show the curvature undergone by ovular primordia in assuming the anatropous position, $\times 12$. *m*—median trace; *v*—ventral trace; *s*—supernumerary trace.

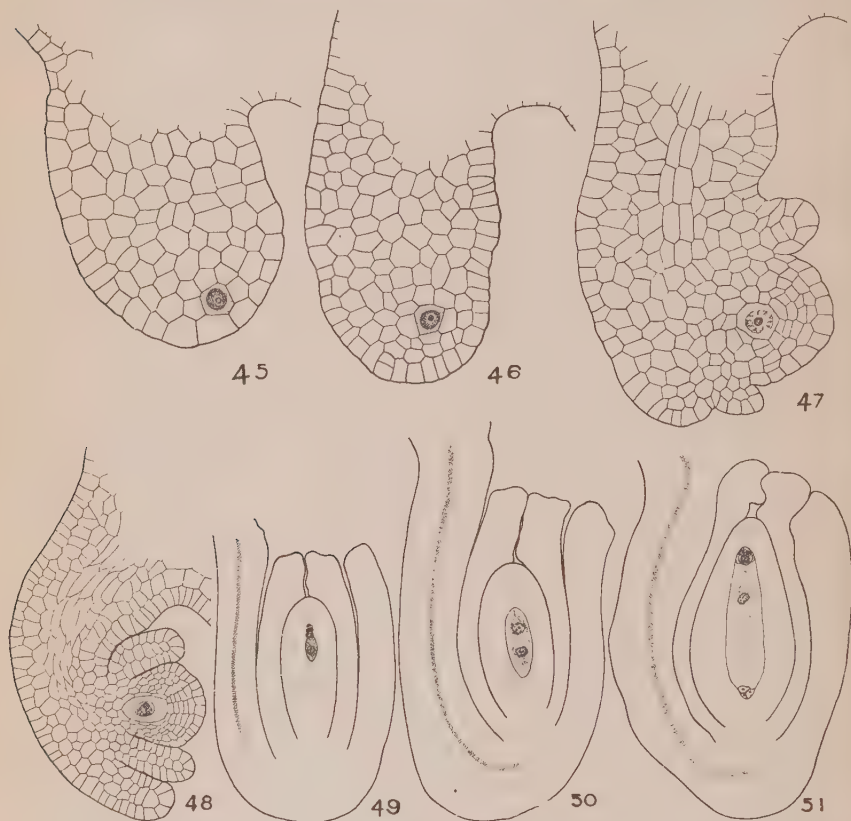
rounding the nucellus; the outer integument comes to have seven or eight layers. As will be shown later, the thickness of the outer integument becomes further increased during post-fertilization development. Both integuments of the mature ovule envelop the nucellus completely and the inner integument organizes the micropyle, *Figs. 49-51*.

The subepidermal archesporial cell, *Fig. 45*, divides into a parietal and a sporogenous cell. The former gives rise to seven to ten layers of parietal tissue that cap the gametophyte; some of the layers persist in the developing seed for a long time, *Fig. 101*. The sporogenous cell functions as the megaspore mother cell, *Figs. 46-48* and after undergoing the reduction divisions gives rise to a linear tetrad of megaspores, the chalazal one of which develops into the eight-nucleate gametophyte, *Figs. 49-51*. The fusion of the polar nuclei takes place usually before fertilization. However, in a few cases it may be postponed until the intervention of the sperm. The antipodals organize into cells and show signs of degeneration before the ovules are fertilized.

STIGMA, POLLEN TUBE, FERTILIZATION

It should be emphasized again that the ovule-bearing region of a *Degeneria* carpel does *not* represent the margin of the carpel and that the ends of the flared-out region of the sporophyll are the true margins. During earlier stages of development, *Fig. 88*, the closely approximated ventral surfaces of the conduplicate carpel form an open cleft extending

from the locule to the exterior. Later, when the ovular primordia are differentiating into nucellus and integuments, the ventral halves of the conduplicate carpel tend to flare apart externally, *Fig. 89*. The epidermal cells of the adaxial surfaces in the region of this flaring develop into pro-

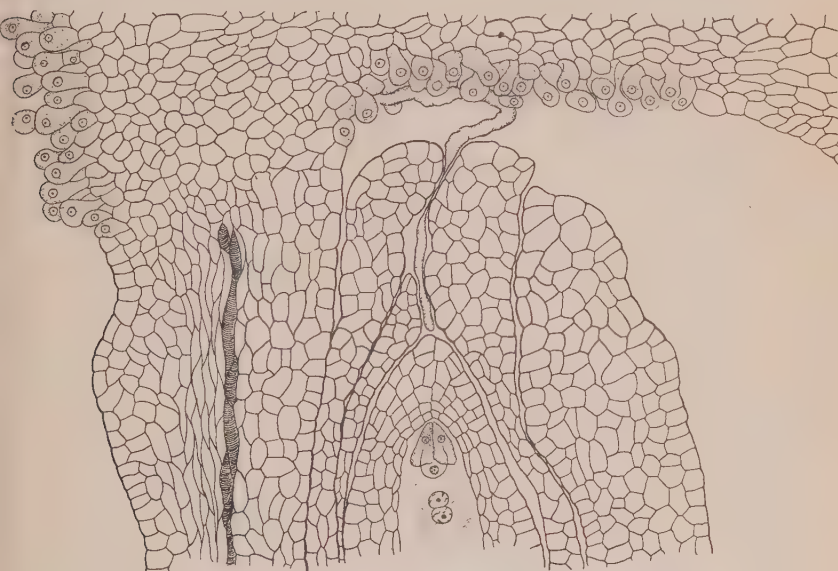


FIGS. 45-51. Figs. 45, 47 and 48 are enlarged from Figs. 41-43 respectively and are mounted with their corresponding orientation. *Fig. 45*. Archesporial cell in the nucellus. *Fig. 46*. Formation of parietal cells. *Fig. 47*. Origin of the integuments. *Fig. 48*. Megaspore mother cell in synizesis; parietal cells have increased in number. *Fig. 49*. Linear tetrad of megaspores, the chalazal one enlarging. *Fig. 50*. Two-nucleate embryo sac. *Fig. 51*. Mature eight-nucleate embryo sac. Figs. 45-48, $\times 182$; Figs. 49-51, $\times 40$.

tuberant hairs, *Figs. 89, 93*. This wave of glandular differentiation spreads outward toward the margins of the carpel and inward into the locule, *Fig. 90*, ultimately extending internally beyond the region of attachment of the ovules, *Fig. 87*. As a result, the narrow cleft between the adaxial surfaces that lie outside the ovule-bearing region becomes occluded by a closely interlocking system of papillate hairs, *Figs. 90, 91, 94*. At anthesis, the hairs on the flaring region grow into a dense felt and many of the individual hairs become two- or three-celled, *Fig. 95*, whereas

in the locule they do not become as long or multicellular. Thus, a greater portion of the adaxial surface of the sporophyll — from the margin to a considerable distance towards the interior of the ovule-bearing region — becomes evenly papillate, *Fig. 28*. As will be shown presently, this entire surface is concerned in the penetration of the pollen tube and hence "stigmatic."

An examination of alcohol-preserved specimens reveals that during pollination the pollen grains become deposited anywhere on the adaxial surfaces of the outwardly flaring parts of the carpel. A few grains were also found attached on the abaxial surface; however, none of these grains show any signs of germination and appear to have lost their cell contents through degeneration. This observation indirectly emphasizes the importance of the papillate surface as an essential factor in the germination



52

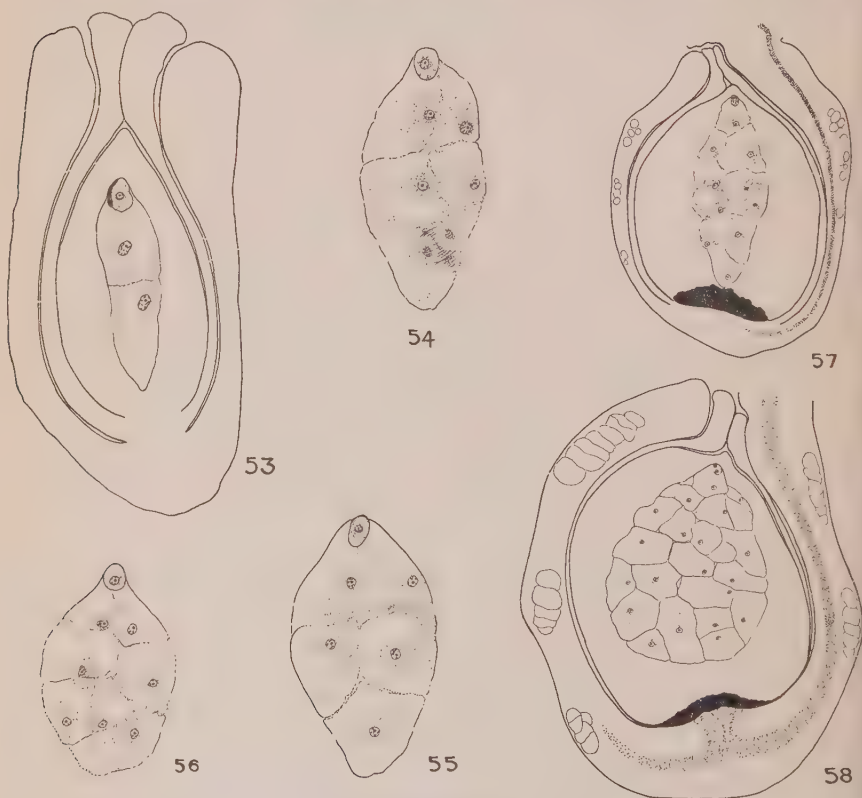
FIG. 52. Micropylar half of a mature ovule with a part of its funicle and associated carpellary tissue showing the papillate epidermis, the course of the pollen tube, etc., $\times 210$.

of the pollen grains in *Degeneria*. The grains that are lodged on the hairy surface put forth pollen tubes. The tube arises not from the narrow region of the germinal furrow but rather from one of its broadened ends, *Fig. 40*. The course of the tube into the carpellary cavity is strictly along the papillate surface and at no time does the tube penetrate the carpellary tissue. Upon reaching the ovule-bearing region, it continues to grow between the funicles and reaches the extension of the papillate surface on the inside of the ovule-bearing region. Here the tube wanders about a little and then characteristically curves back and enters the micropyle, *Fig. 52*.

After reaching the lower end of the micropylar canal, the tube bores through the apex of the nucellus until the upper end of the embryo sac is reached. During the discharge of the pollen tube contents into the embryo sac, one of the synergids is usually destroyed. Double fertilization takes place in a typical manner. Triple fusion precedes syngamy.

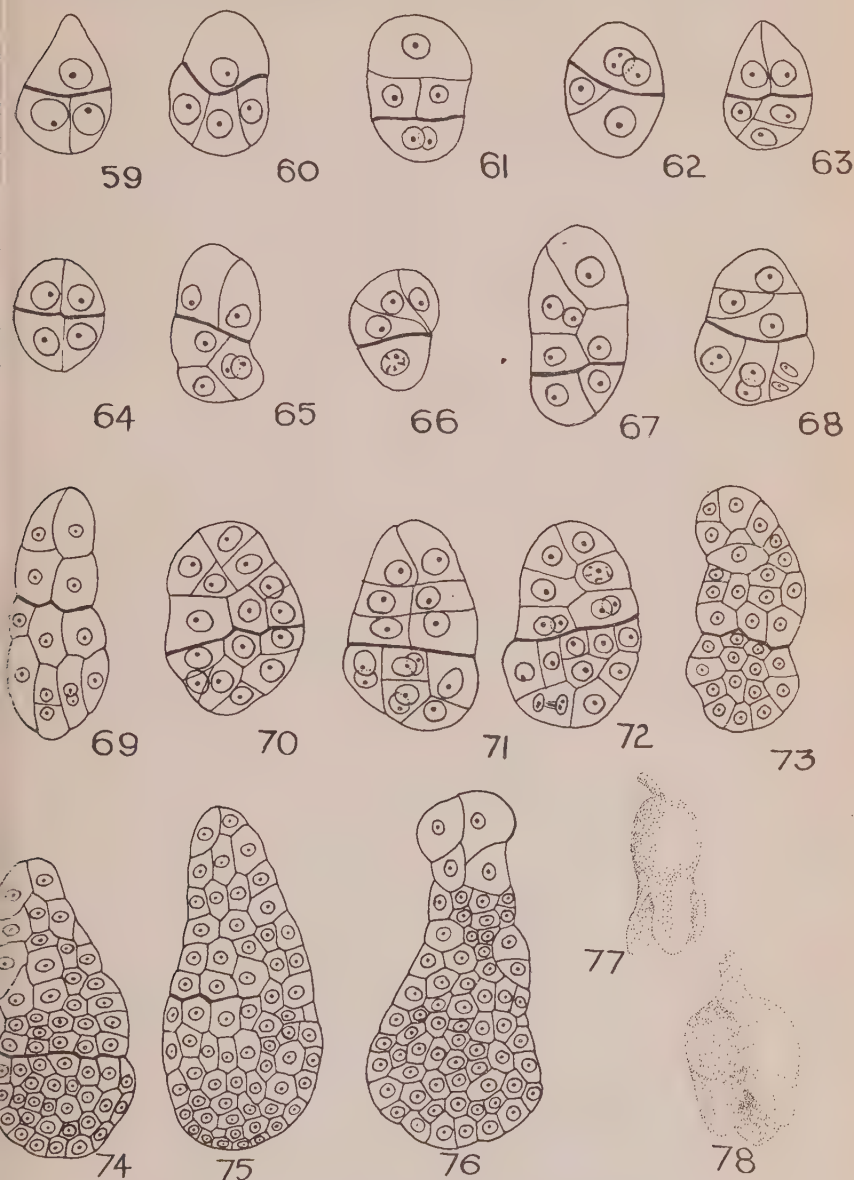
ENDOSPERM, EMBRYO

The first division of the primary endosperm nucleus results in a transverse chambering of the embryo sac, *Fig. 53*. The separating membrane is very thin and delicate. The nuclei of both chambers divide almost simultaneously and in quick succession, each division being followed by wall deposition until the embryo sac cavity becomes filled with a mass of extremely thin-walled cells, *Figs. 54-58*. The sequence of the divisions, however, does not follow any prescribed method. The tissue keeps on steadily increasing at the expense of the nucellus and finally occupies



FIGS. 53-58. *Fig. 53.* An ovule showing two-celled endosperm and zygote, $\times 40$. *Figs. 54-56.* Early stages in the development of endosperm, $\times 100$. *Figs. 57, 58.* Slightly later stages; note the differentiation of oil-bearing cells in the outer integument, the pad of degenerated nucellar cells (shown in black) at the chalaza and the extension of the vascular bundle on to the opposite side in *Fig. 58*, $\times 30$.

the entire space enclosed within the integuments. The development of ruminations in this tissue will be considered in connection with the seed.



FIGS. 59-76. Stages in the development of embryo; explanation in text. The heavy transverse line in the figures denotes the boundary of the cells derived from the basal and terminal cells of the two-celled proembryo, $\times 283$. FIGS. 77, 78. Embryos dissected from mature seeds; note the three cotyledons, swollen hypocotyl and talk-like suspensor, $\times 90$.

The zygote divides only after about 300 endosperm cells are formed. The first division is in a transverse plane and results in the formation of basal and terminal cells. The subsequent method of segmentation does not follow a strict pattern, as may be seen from *Figs.* 59–69. However, when a fairly large amount of material is studied, certain broad trends of developmental pattern suggest themselves. The second cell generation commences first in the terminal cell and this is invariably by a vertical wall, whereas the segmentation of the basal cell is generally delayed, *Figs.* 59, 60, 65. The division in the latter cell also is usually by a vertical wall, *Figs.* 62–65, thus resulting in two superposed tiers of two cells, *Fig.* 64; less frequently, the wall laid down is oblique or transverse. The division of the basal and terminal cells may be more or less simultaneous or in rare instances the development of the terminal cell lags behind, *Figs.* 66, 67. However, subsequent divisions follow in rapid succession, resulting in an ovoid mass of cells. The derivatives of the basal and terminal cells are distinguishable for a fairly long time, *Figs.* 73–75.

In spite of the highly plastic nature of the early segmentation, the method of tissue differentiation in the undifferentiated mass of cells is quite stabilized. All the derivatives of the terminal cell and about half of the derivatives of the basal cell enter into the construction of the embryo proper. The other half takes part in the construction of a massive suspensor. With the differentiation of the suspensor, the identity of the derivatives of the basal and terminal cells becomes obliterated, *Fig.* 76. In the mature embryo, the suspensor persists as a short stalk, *Figs.* 77, 78, 106; the hypocotyl region is bulbous; the cotyledons are well differentiated and three or rarely four in number. Internally, the stem and root apices, an incipient root cap and the procambial system are well organized. However, the size of the embryo is significantly small in relation to the large amount of endosperm, *Fig.* 79.

The cotyledonary number in *Degeneria* is remarkable. In *Magnolia grandiflora* (4) and possibly in other species of this family, tricotyledonous embryos are encountered occasionally as abnormalities. On the other hand, a tricotyledonous development in *Degeneria* seems to be the rule, as not even a single instance of an embryo with two cotyledons was seen among the large number of seeds examined. The following data give an

COLLECTION NUMBER	NUMBER OF SEEDS EXAMINED	TRICOTYLEDONOUS EMBRYOS	TETRACOTYLEDONOUS EMBRYOS
5880	a. 42 from 3 fruits	34	8
	b. 50 free seeds	44	6
6190	a. 46 from 4 fruits	39	7
	b. 50 free seeds	40	10
6318	a. 72 from 6 fruits	63	9
	b. 50 free seeds	42	8
	310	262	48
		or, nearly 87%	or, nearly 13%

estimate of the frequency of the occurrence of the tricotyledonous and tetracotyledonous embryos in *Degeneria*.

The embryogeny of magnoliaceous species such as *Magnolia virginiana* (5), *M. grandiflora* (4), *M. Soulangeana*, *Michelia fuscata*, *M. Champaca* and *Liriodendron tulipifera* (unpublished observations of the author) presents several points of similarity with *Degeneria*. The plasticity in the developmental pattern of the two-celled proembryo, the organization of an oval mass of undifferentiated cells before tissue differentiation, the development of a massive suspensor and its persistence in the mature embryo, the swollen nature of the hypocotyl, the nearly triangular shape of the cotyledon, and finally the size relationships of the mature embryo and endosperm, are the more significant resemblances. Although the embryos of *Degeneria* are prevailing tricotyledonous, such tricotyledonous nodes are of not infrequent occurrence in large populations of seedlings of magnoliaceous plants.

SEED

Fertilization affects not only the structures within the embryo sac but also other parts of the ovule. The fertilized ovule undergoes enormous increase in size and the unfertilized ones soon degenerate, *Fig. 97*. In the former, the nucellar cells abutting upon the antipodal end of the embryo sac soon begin to degenerate and stain very deeply, *Fig. 96*. With subsequent growth of the ovule, the mass of degenerating cells becomes compressed in the form of a pad, *Figs. 57, 98*. More and more nucellar cells in the chalazal region become involved and cause an expansion in the width of the pad, *Fig. 58*. During later stages, this structure becomes very prominent and is contacted by the ramifications of the vascular bundle of the ovule, *Figs. 99, 100*. Some of the magnoliaceous genera also exhibit a similar feature in varying degrees.

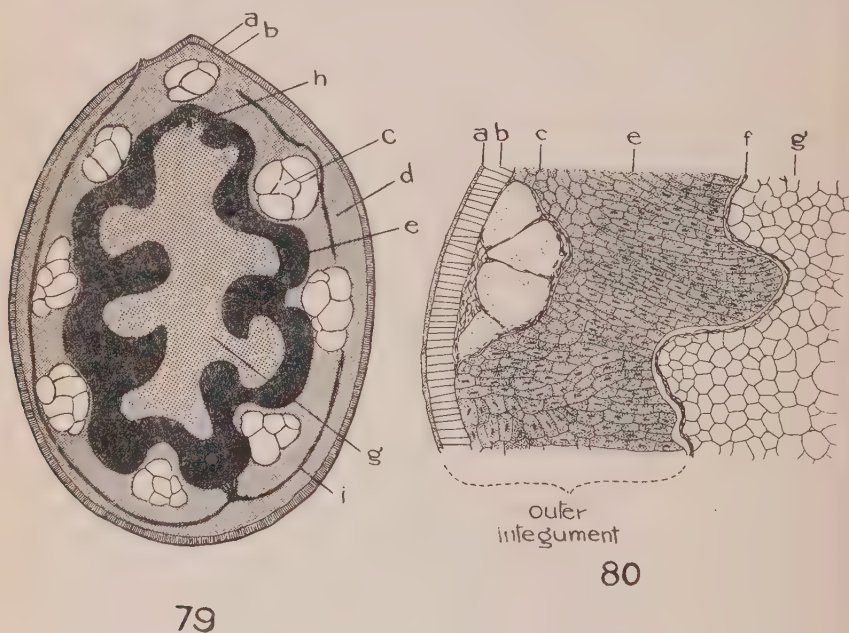
At the time of fertilization, the outer integument consists of about eight layers of cells, all the cells appearing homogeneous. After fertilization, clusters of two to ten cells in the outer layers develop into oil-bearing cells, *Figs. 57, 58, 99*. Some of the walls of the oil cells break down during later stages to result in cyst-like cavities. In the mature seed they become very conspicuous and occupy a more superficial position, *Figs. 79, 100, 102*.

Hand in hand with the early segmentation of the zygote, localized patches of cells from the innermost layers of the outer integument begin rapid divisions largely by tangential walls and grow out in the form of wedges, *Fig. 102*. Thus the entire inner surface of the outer integument is thrown into ridges of varying pitch and the continuously increasing endosperm occupies the contour of this surface. The exterior of the mature endosperm thus becomes irregularly grooved and cleft, *Figs. 79, 105*, and presents all the essential characteristics of a ruminated type.

It must be emphasized that the nature of the rumination in *Degeneria* is less exaggerated than in Annonaceae, Myristicaceae, Palmae, etc. In these families, the ingrowths of the integument penetrate the endosperm

far deeper in the form of thin transverse plates, whereas in *Degeneria*, they are more massive and wedge-shaped than plate-like; also, in the families cited above, the partitions are more or less transverse and parallel to one another, or extend in a converging manner from the periphery, thus exhibiting a specialized manifestation, whereas in *Degeneria* the wedges are scattered indiscriminately and the form of the individual wedges is somewhat fluctuating. In some members of the Myristicaceae (6), it is the inner integument that takes part in the organization of the rumination, but in *Degeneria* it is clearly the outer.

The epidermis of the mature seed becomes covered by a thick cuticle and the epidermal cells undergo conspicuous elongation in a radial direction, *Figs. 79, 80*. That part of the outer integument wherein the oil cells are located continues to persist as a succulent outer coat. The inner



FIGS. 79, 80. *Fig. 79.* Diagrammatic representation of a median longitudinal section of a mature seed, the plane of section passing through the vascular bundle, $\times 20$. *Fig. 80.* A portion of the seed coat and endosperm of *Fig. 79* enlarged to show the histological details, $\times 40$. *a*—cuticle; *b*—epidermis; *c*—oil-bearing cells; *d*—fleshy coat; *e*—stony coat; *f*—inner integument; *g*—endosperm; *h*—embryo; *i*—vascular bundle.

part together with its ruminated outgrowths undergoes considerable hardening and transforms into an inner stony coat, *Figs. 79, 80, 102*. The process of hardening first commences in the cells of the wedges and gradually works outward. Due to the uneven pattern of hardening, the stony coat becomes irregularly ruminate on its outer surface also, *Figs. 79, 103*.

The inner integument becomes crushed into a membranous covering between the endosperm and the stony coat. The vascular bundle extends to the opposite side of the funicle as far as the micropylar end, *Fig. 79*.

At this point, a reference to the nature of the hardening material in the cells of the stony coat deserves special mention. In *Degeneria*, as also in magnoliaceous genera, the cells become filled with vacuolar substances during development and finally the entire cell contents are rendered excessively hard; the cell walls, however, remain thin and the cells do not increase in size, *Fig. 80*. Thus the hardness in these cases is due to the transformation of the cell contents. On the other hand, in the corresponding tissue of annonaceous genera, the cell walls become heavily lignified and the individual cells elongate in the form of sclerotic fibres; the secondary thickening frequently occludes the cell lumen. Thus the hardening is due to the lignification of the cell walls. This important feature serves to distinguish the seeds of the Magnoliaceae and Degeneriaceae from those of the Annonaceae.

The mature seeds of the families Degeneriaceae, Magnoliaceae and Himantandraceae share several features in common, at the same time showing significant differences in histological details. In all the three families, the inner integument is reduced to a membranous layer and the outer integument increases in thickness during post-fertilization development and takes part in the construction of the seed coat; the vascular bundle becomes extended from the chalazal side toward the micropyle; and the minute embryo is embedded in an extensive endosperm. The seeds of the Degeneriaceae and Magnoliaceae are highly opaque, oval or round with a fleshy exterior, whereas those of the Himantandraceae are decidedly less opaque, suborbicular, greatly compressed and submembranous. The outer integument differentiates into fleshy and stony coats in the former families, whereas in the latter, such a differentiation is wanting; instead, the outer cell layers attain a cartilaginous texture. The fleshy layer in the Degeneriaceae and Magnoliaceae contains the oil-bearing cells. In the former family, their distribution is characteristically in clusters and in the latter, isolated and diffuse. Whether the seed coat of *Himantandra* contains oil cells could not be determined from herbarium specimens. The nature of hardening of the stony coat is essentially similar both in the Degeneriaceae and Magnoliaceae. The epidermal cells lining the exterior of the seed in the Magnoliaceae and Himantandraceae are isodiametric in shape, whereas in *Degeneria* they are conspicuously elongated radially.

FRUIT

Long before anthesis, the carpellary wall differentiates into two regions. The cells of the outer region stand out more prominently with their darkly staining walls and protoplasts in contrast to the faintly staining inner region, *Fig. 81*. After fertilization, important changes occur within each of them. The cells of the outer region appear to be retarded in

meristematic activity, numerous spicular cells develop, and the vascular system built by the median trace becomes excessively ramified. On the other hand, the cells of the inner region suddenly step up their meristematic activity and grow into the carpellary cavity in the form of lobes of a spongy consistency. The lobes intrude between the developing ovules, at the same time overtaking the degenerate ones and pushing them to one side, *Fig. 97*. Ultimately the entire capillary cavity is densely packed with the spongy ingrowths, *Figs. 98, 99*, and the interior of the fruit becomes fleshy. The outer region of the carpellary wall, in which the spicular cells and vascular system ramify, becomes increasingly tough and coriaceous.

According to field observations of Dr. Smith, the fruits dehisce along the ventral suture after falling from the tree. The seeds become disseminated through this split, also perhaps facilitated by the decay of the coriaceous wall. In such fruits, the vascular skeleton built by the median and ventral traces appears as a coarse and closely woven mesh, and the supernumerary vascular traces, which have now assumed the form of large cords, clasp the outer surface of the mesh, *Fig. 29*.

The observation of Bailey and Smith (1) that the seeds of one row are strictly sessile, while those of the other row are borne on slender elongated funicles, needs to be amended in view of the large amount of material now available. Although such a condition occurs in a few instances, it is subject to numerous exceptions. Sessile as well as long-funicled seeds are indiscriminately distributed and invariably the former outnumber the latter. Furthermore, the distinction between the two categories is one of degree. The manifestation of these conditions seems to be largely dependent upon the degree and direction of pressure exerted by the invading spongy lobes of the carpellary wall on the developing seeds. The rate of ingrowth is by no means uniform and simultaneous throughout the surface, especially in the early stages. If the activity of the spongy ingrowth in the immediate vicinity of the micropylar end of the seed dominates, it is likely that the ovule in question is carried more towards the interior of the carpel, whereby the funicle also becomes correspondingly stretched. On the other hand, if the activity of the lobes from the opposite direction dominates and tells upon the chalazal region of the ovule, it is possible that the funicle is not subjected to extensive stretching. It may be further noted that such a differential method of growth of the carpellary wall is also responsible for the frequent readjustment or reorientation of the seeds in the mature fruit.

In dried fruits, the fleshy region shrinks and is pressed back against the outer coriaceous wall. The latter becomes very hard, as might be anticipated in view of its high ratio of spicular cells and vascular elements. When the seeds are broken from their points of attachment with the carpellary wall, some of the shrunken spongy tissue also becomes detached and forms a cupule-like appendage on the micropylar end of the seed, as pointed out by Bailey and Smith (1). However, it must be borne in mind that the seed in reality has no true appendages and that what

appears to be a cupular appendage is clearly the dried remnants of the spongy ingrowth of the carpellary wall.

RELATIONSHIPS OF THE DEGENERIACEAE

A critical evaluation of the various vegetative and reproductive characteristics of *Degeneria*, *Himantandra* and the Magnoliaceae (sensu strictu) with regard to their mutual affinities and systematic position has already been published by Bailey and his coworkers (1, 3). Only a few points that are not covered by them will be dealt with here.

The vascularization pattern of the cotyledonary node of *Degeneria* differs from that in most of the investigated species of Magnoliaceae. In *Degeneria*, each of the three or four cotyledons has a trilacunar attachment, whereas in most Magnoliaceae the four lateral strands of the paired cotyledons arise by the bifurcation of two traces, each related to an independent gap. When three cotyledons are formed, the six lateral strands arise by the bifurcation of three independent traces. However, a nodal anatomy resembling that of *Degeneria* has been reported in *Magnolia Soulangeana* (7) and may ultimately be found to occur in seedlings of other representatives of the Magnoliaceae.

The nodal anatomy and the vascularization of the adult petiole follow a characteristic and basically similar plan in the Degeneriaceae, Magnoliaceae and Himantandraceae, a fact that has already been recorded (3). Furthermore, in the case of the Degeneriaceae and Magnoliaceae, there are similar transitions between the trilacunar nodes of the first seedling leaves and the multilacunar nodes of leaves from older plants. The hemarginate nature of the first one or two leaves succeeding the cotyledons characterizes *Degeneria* and is of not uncommon occurrence in Magnoliaceae.

During microsporogenesis, the method of differentiation of the parietal and sporogenous tissues, the organization of a binucleate secretory tapetum from the innermost layer of the parietal cells,⁴ the simultaneous method of meiosis, the prevalence of a tetragonal arrangement of the microspores at the tetrad stage, the cutting off of the generative cell towards the exterior side of the tetrad, and the two-celled shedding condition of the pollen grains are features shared by both *Degeneria* and the Magnoliaceae. The broad microsporophylls of *Degeneria* and *Himantandra*, bearing long, slender, deeply embedded sporangia have similar counterparts in certain representatives of the Magnoliaceae. However, the stamens of this family differ from those of *Degeneria* and *Himantandra* in having a less typically parenchymatous hypodermal layer.

The origin and differentiation of the nucellus, the thin inner and thick outer integuments, the formation of seven to ten parietal layers in the ovule, the monosporic eight-nucleate embryo sac and the ephemeral nature

⁴ Maneval (5) reports that the tapetum in *Magnolia virginiana* is cut off from the sporogenous cells. This observation seems to be erroneous. In *M. Soulangeana*, *M. stellata*, as well as in *Michelia fuscata* and *Liriodendron tulipifera*, I have seen only a parietal origin of this layer.

of the antipodals of *Degeneria* are present point by point in the Magnoliaceae. The *ab initio* cellular endosperm,⁵ the excessive broadening of the chalazal region of the ovule, and the development of the darkly-staining pad of degenerated nucellar cells at the chalaza are again a combination of characters that are common to *Degeneria* and the Magnoliaceae; the presence of the last two characters in *Himantandra* appears to be almost certain, as can be judged from herbarium material. In *Degeneria* the endosperm becomes ruminated, and this feature has no counterpart either in the Magnoliaceae or in *Himantandra*.

The plasticity in the sequence of early cell divisions in the two-celled proembryo, the organization of a massive suspensor which is not clearly delineated from the body of the embryonal mass in the early stages, and the bulbous nature of the hypocotyl in the mature embryo are a set of characters in the magnoliaceous embryogeny. The overwhelming proportion of tricotyledonous embryos appears to be confined to *Degeneria* alone.

The outer integument takes part in the construction of the seed coat and the vascular bundle extends on the opposite side in the seed in all the three families, and the inner integument is reduced to a membranous layer. In *Degeneria* and the Magnoliaceae, the outer integument differentiates into fleshy outer and stony inner coats; such a distinction is absent in *Himantandra*, and instead, some of the outer cell layers become modified so as to render the seed coat cartilaginous. The stony coat of *Degeneria* is ruminated internally as well as externally, whereas that of the Magnoliaceae is smooth; however, the histological nature of hardening in both families is identical. Although the fleshy coat of *Degeneria* and the magnoliaceous genera contains oil cells, the pattern of distribution is different in the two families.

The fruit of *Degeneria* is relatively large as compared with that of *Himantandra* or of the Magnoliaceae. Its interior is packed with fleshy outgrowths of the carpellary tissue and the seeds become embedded in it. In the Magnoliaceae, the fruit is either dry or succulent and in *Himantandra*, fleshy. However, in the fleshy fruits of the latter families, the carpellary wall does not form spongy lobes that embed the seeds as in *Degeneria*.

It will be evident from the brief review presented above that a large number of embryological characters are common to all three families. Nevertheless, the dissimilar characters are seen in specific combinations in each of them. Thus the summation of evidence again points to the

⁵ Earle (4) states that in *Magnolia grandiflora*, "The early divisions of the endosperm nucleus are very rapid and the number of free nuclei formed is comparatively small. . . . Wall formation occurs shortly after the appearance of these free nuclei . . .". But in *M. virginiana* (5), *M. Soulangeana*, *M. stellata*, *Michelia fuscata* and *Liriodendron tulipifera* (unpublished observations of the author), the endosperm is cellular from inception. The walls of this tissue in the early stages are extremely delicate and hard to see as also in *Degeneria*, unless the sections are counterstained with eosin or fast green. It is very likely that the presence of walls in *Magnolia grandiflora* escaped Earle's notice.

same conclusion already reached by Bailey, Nast and Smith (3) that "in the Degeneriaceae, Himantandraceae and Magnoliaceae we are concerned with three distinct but closely related families."

SUMMARY

Additional information on the anatomy of the secondary xylem, node, petiole, seedling, flower, fruit and seed of *Degeneria vitiensis* is presented.

Ontogenetic and anatomical evidence indicate that the staminodes are sterile microsporophylls in which the development of the sporogenous tissue becomes arrested.

After supplying the vascular traces to the perianth and androecial whorls, a large number of bundles are left over in the floral axis. They reunite into seven to nine larger bundles and enter the carpel. Only three of these behave as true carpellary traces. The remaining traces represent the residual vascular traces that once supplied the now missing carpels. The anatomy of bicarpellate flowers also supports the hypothesis that the ancestral flower of *Degeneria* was multicarpellate.

The ovules derive their vascular supply in part from the branches of the ventral veins, in part from those of the median vein, and in part from the branches of both sets of veins. The stigmatic papillae extend to a considerable distance towards the interior of the ovule-bearing region. The ontogenetic occlusion of the cleft of the carpel is accomplished by the interlocking arrangement of the papillae. The germination of the pollen grain and the path of the pollen tube is largely determined by this papillate surface.

The germinal furrow of the pollen grain develops on its distal face. A summation of evidence from the development of the gametophytes, endosperm and embryo, and the structure of the node, petiole, seed and fruit, confirms the earlier conclusion that in the Degeneriaceae, Himantandraceae and Magnoliaceae we are concerned with three distinct but closely related families.

LITERATURE CITED

1. BAILEY, I. W. & A. C. SMITH. Degeneriaceae, a new family of flowering plants from Fiji. Jour. Arnold Arb. 23: 356-365. 1942.
2. BAILEY, I. W. & C. G. NAST. The comparative morphology of the Winteraceae. II. Carpels. Jour. Arnold Arb. 24: 472-481. 1943.
3. BAILEY, I. W., C. G. NAST & A. C. SMITH. The family Himantandraceae. Jour. Arnold Arb. 24: 190-206. 1943.
4. EARLE, T. T. Embryology of certain Ranales. Bot. Gaz. 100: 257-275. 1938.
5. MANEVAL, W. E. The development of *Magnolia* and *Liriodendron*, including a discussion of the primitiveness of the Magnoliaceae. Bot. Gaz. 57: 1-31. 1914.
6. MAURITZON, J. Contributions to the embryology of the orders Rosales and Myrtales. Lunds Univ. Arsskr. N.F. Avd. 2, 35(2): 1-120. 1939.
7. THOMAS, E. N. Seedling anatomy of Ranales, Rhoadales and Rosales. Ann. Bot. 28: 695-733. 1914.

EXPLANATION OF PLATES

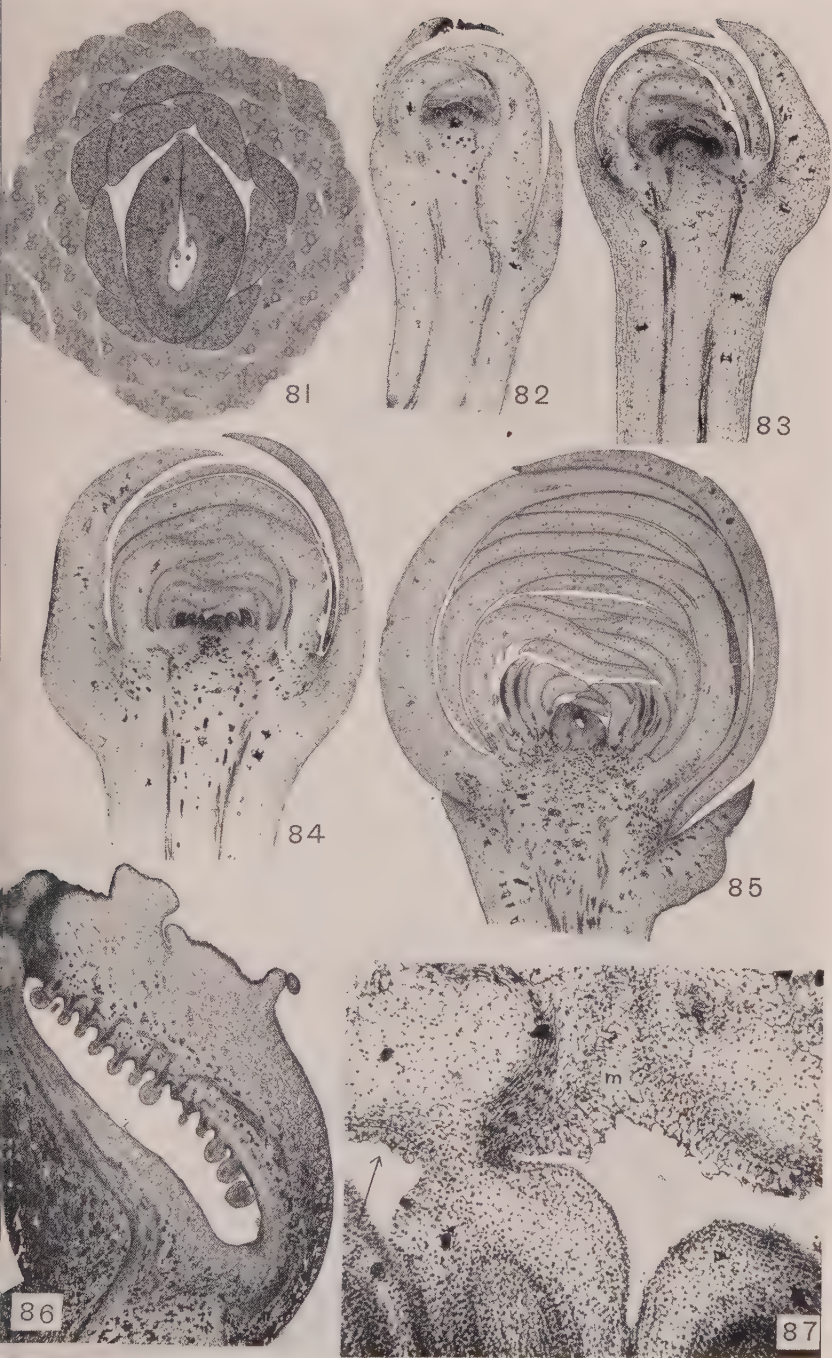
PLATE I. FIGS. 81-87. *Fig. 81.* Transverse section of a flower bud long before anthesis; perianth removed, $\times 16$. *Figs. 82-85.* Longitudinal sections of flower buds at different stages of development, $\times 10$. *Fig. 86.* Longitudinal section of a young carpel in the plane of conduplication to show the alignment of ovules and the slanting position of the carpellary cavity, $\times 21$. *Fig. 87.* Transverse section of a portion of a carpel at the time of fertilization to show the extension of the papillate epidermis on the inner side of the ovule-bearing region (indicated by arrow), $\times 50$. *m* — micropylar canal occluded by papillae.

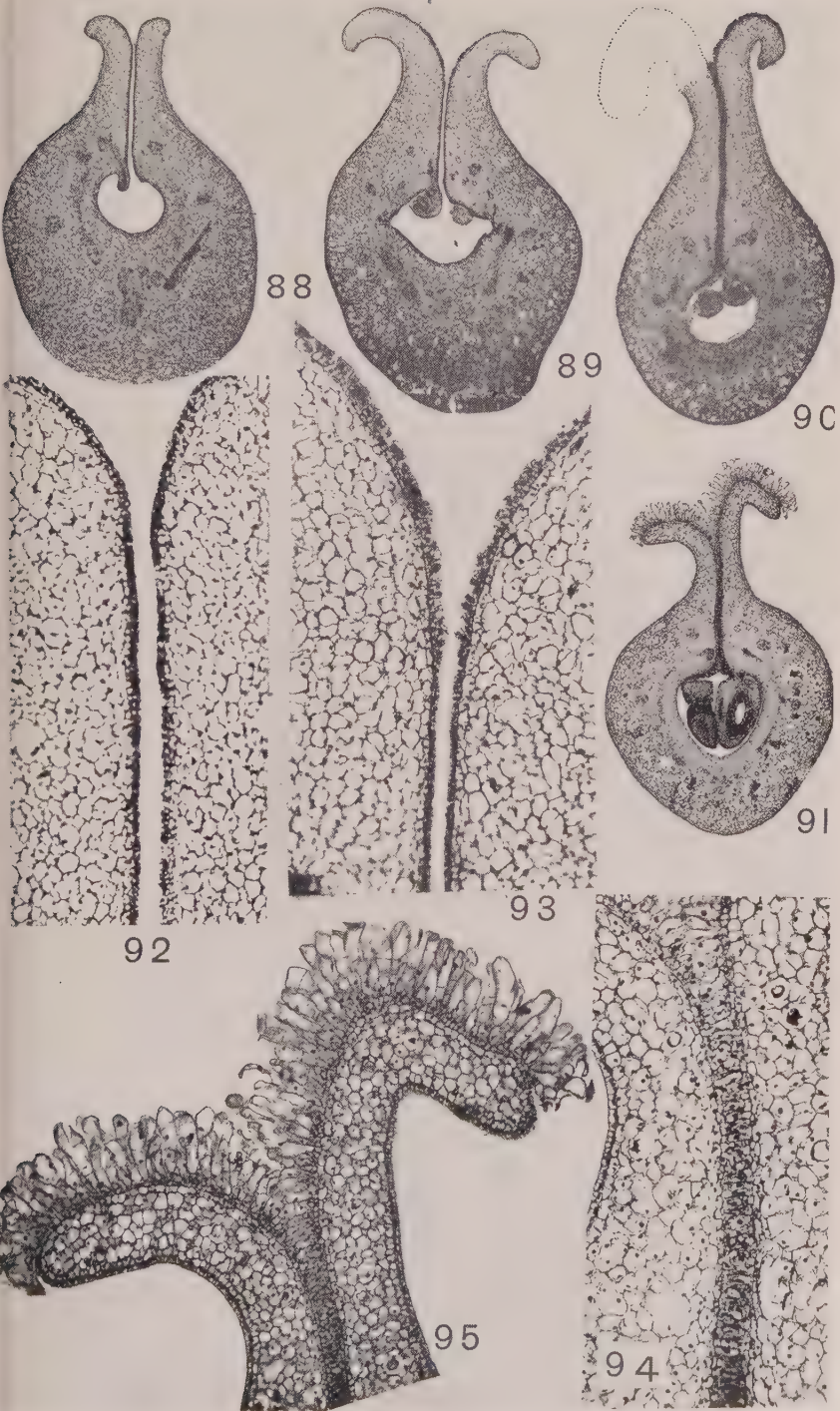
PLATE II. FIGS. 88-95. *Figs. 88-91.* Transverse sections of carpels at different stages of development of the papillate epidermis. *Fig. 88.* Very young stage; the adaxial surfaces do not show any papillate differentiation at this stage (detail in *Fig. 92*). *Fig. 89.* The epidermal cells of the flaring ventral surfaces are beginning to protrude (detail in *Fig. 93*). *Fig. 90.* The epidermal papillae have developed toward the interior of the carpel and the cleft has become plugged (detail in *Fig. 94*). *Fig. 91.* At anthesis. The papillae of the flaring ventral surfaces have elongated and a large number of them have become two- or three-celled (detail in *Fig. 95*). *Figs. 88-91*, $\times 21$; *Figs. 92-95*, $\times 64$.

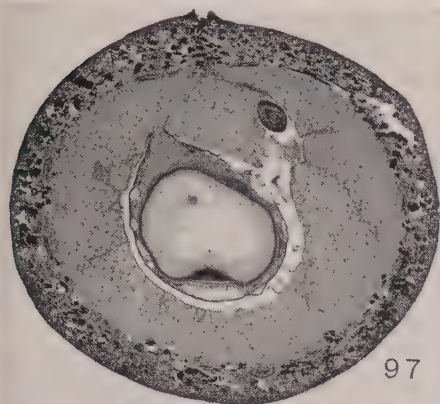
PLATE III. FIGS. 96-102. *Fig. 96.* An ovule after fertilization. Note the degenerated and darkly-staining nucellar cells at the chalazal end of the ovule, $\times 38$. *Fig. 97.* Transverse section of a young fruit to show the ingrowth of the carpellary wall in the form of spongy lobes. Also note the development of spicular cells in the outer layers of the carpel, $\times 23$. *Fig. 98.* A portion of the transverse section of a fruit, slightly older than in *Fig. 97*. The spongy tissue is invading between the ovules. The darkly-staining chalazal pad is increasing in breadth (compare the seed in *Fig. 58*, which is from a corresponding stage in development), $\times 20$. *Fig. 99.* Same, at a still later stage. The ovule is cut somewhat obliquely. The characteristic distribution of oil cells, the chalazal pad and its connection with the vascular bundle, and the effect of the ruminant outgrowth of the inner surface of the outer integument on the endosperm, are clearly seen, $\times 18$. *Fig. 100.* Detail of the chalazal region of a young seed at a stage similar to *Fig. 99*, showing the pad and its relation to the surrounding tissue, $\times 20$. *Fig. 101.* Micropylar region of a young seed (outer integument removed) showing the endosperm and embryo. Note the persistence of parietal cells in contact with the suspensor-end of the embryo, $\times 40$. *Fig. 102.* A portion of a young seed in section showing the wedge-shaped ruminant outgrowths from the inner surface of the outer integument, $\times 30$.

PLATE IV. FIGS. 103-106. *Fig. 103.* External surface of the mature stony coat of the seed, $\times 10$. *Fig. 104.* Internal surface of the same, $\times 10$. *Fig. 105.* Endosperm dissected from an immature seed to show the early stages of rumination, $\times 10$. *Fig. 106.* A group of mature embryos, $\times 30$.

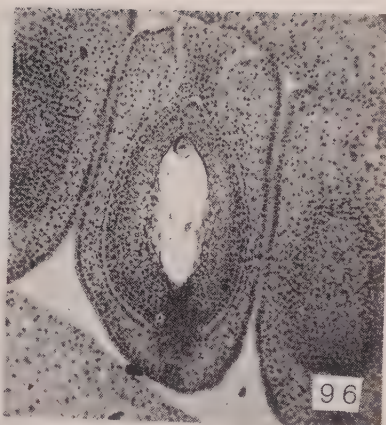
INSTITUTE FOR RESEARCH IN GENERAL PLANT MORPHOLOGY,
HARVARD UNIVERSITY.



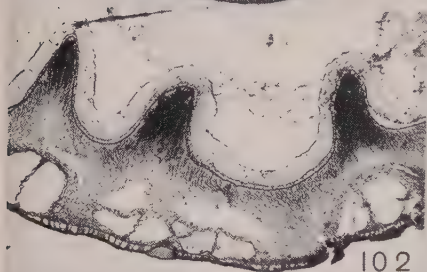




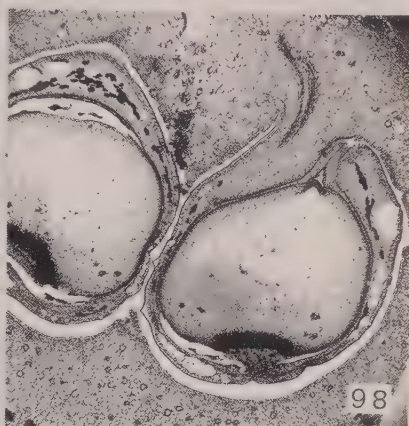
97



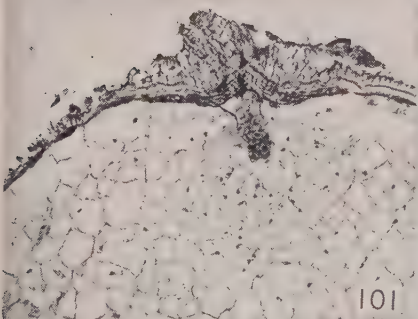
96



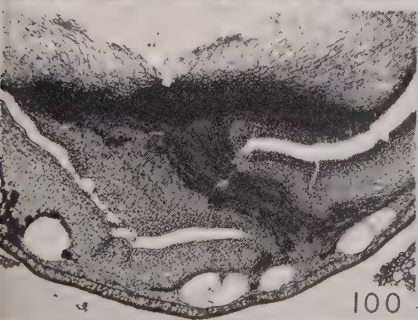
102



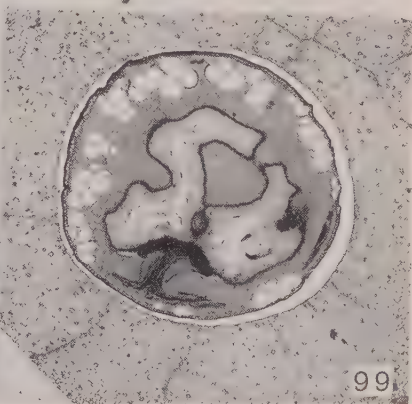
98



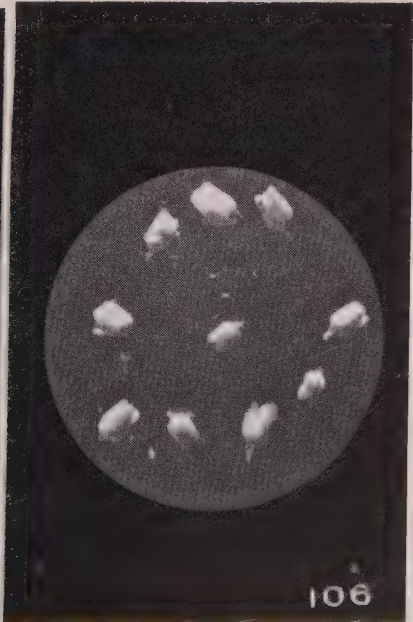
101



100



99



MORPHOLOGY OF THE DEGENERIACEAE

PLANTAE PAPUANAE ARCHBOLDIANAE, XVIII *

E. D. MERRILL and L. M. PERRY

THIS ARTICLE, like the others of this series, is a miscellany. In it we have tried to bring together the misplaced odds and ends of families already named, in addition to our consideration of the Sterculiaceae, Solanaceae, and Cucurbitaceae. Owing to the official retirement of the senior author in June, 1948, this will be the last of these joint papers. For the convenience of those who are particularly interested in New Guinea flora we are adding an index of the families and genera included in this series.

TAXACEAE

Dacrydium xanthandrum Pilger, Bot. Jahrb. 69: 252. 1938.

In addition to the specimens cited by Pilger in the original description, we have the following.

NORTHEAST NEW GUINEA: Ogeramnang, *Clemens* 6408, May 1937, alt. 1750 m.; Yunzaing, *Clemens* 6488, June 1937, alt. 1350 m.

SOLOMON ISLANDS: Bougainville: Kupei Gold Field, *Kajewski* 1694, 1709, April 1930, alt. 950 m., rare in rain-forest (tree up to 25 m. high). Closely allied but perhaps not conspecific with these are the following two specimens from the Solomon Islands: Ysabel: Mt. Sasari, *Brass* 3264 (♂), December 1932, alt. 1100 m., found only on summits of highest peaks (thick boled tree seldom more than 15 m. tall; branches spreading, upturned). Guadalcanal: Uulolo, Tutuve Mt., *Kajewski* 2652, May 1931, alt. 1200 m., rare, in gold-mining country.

CARYOPHYLLACEAE

Sagina monticola sp. nov.

Herba perennis; caulibus vetustioribus glabris, novellis puberulo-glanduloso-pilosulis (pilis tenuissimis), breviter sarmentosis vel decumbentibus ad nodos saepe radicanibus et demum plantas novellis evolventibus apice floriferis; foliis inferioribus subcarnosis subrosulatis, linearibus, mucronatis, usque 3.5 cm. longis, vix 5 mm. latis, basi (2.5 mm. latis) late vaginantibus, margine et subtus costa distanter ciliolatis, supra planis, subtus convexiusculis, utrinque minute pustulatis; foliis superioribus similibus sed minoribus, 3–5 mm. longis; pedicellis tenuibus, 0.6–2 cm. longis, consperse glanduloso-puberulis; floribus pentameris; sepalis glanduloso-puberulis, ellipticis, 3–4 mm. longis, 2 mm. latis, apice late obtusis, e basi 3-nerviis, nervis ramosis; petalis albis, 4–5 mm. longis, oblongis, apice rotundatis; staminibus 10, filamentis exterioribus 2.5 mm. longis, basi glandula insidentibus, interioribus paullo brevioribus eglandulosis; ovario ovoideo 3 mm. longo, 2 mm. lato; stylis 5, ex apice ad medium papilliferis; capsulis 4 mm. longis; seminibus 0.6–0.8 mm. longis, oblique subrotundatis, extus minute muriculatis.

* Botanical results of the Richard Archbold Expeditions. See Jour. Arnold Arb. 27: 193–233. 1946.

NETHERLANDS NEW GUINEA: Bele River, 18 km. northeast of Lake Habema, *Brass 11569* (TYPE), November 1938, alt. 2350 m., rooting in earthy niches on a sparsely vegetated limestone precipice (flowers white).

This species was published, Jour. Arnold Arb. 23: 388. 1942, as *Sagina echinosperma* Hayata. Since the war, Dr. Hiroshi Hara, who has done some work on this group, called our attention to the fact that the New Guinean plant is clearly distinct from the Formosan plant which has been proved on further study to be *S. japonica* (Sw.) Ohwi, common in Japan. The latter has short (less than 2 mm. long) petals, smooth leaves, and 5–8 stamens. The habit of this plant is rather distinctive. It suggests a slender short caudex-like stem covered by relatively long leaves with overlapping very much broadened bases, from this stem or stem-like base slender decumbent branches appear to grow, and these eventually develop new plants at the nodes, but may also terminate in an inflorescence. Nothing in the duplicates indicates a tangled mass of branches such as one expects to see in *Sagina*.

AQUIFOLIACEAE

Ilex malaccensis Loesener, Nov. Act. Abh. Leop.-Carol. Akad. Naturf. (Monog. Aquifol.) 78: 432. 1901, var. *stenura* var. nov.

A specie recedit foliis oblongis, 10–17 cm. longis, 2.4–5 cm. latis (uno 8.2×2.5 cm.), basi obtusis vel cuneatis, apice caudato-acuminatis, acumine 1.5–2 cm. longo, basi 4 mm. lato, apicem versus ± 1.5 mm. lato, obtuso.

BRITISH NEW GUINEA: Central Division, Mafulu, *Brass 5175* (TYPE of var.), Sept.–Nov. 1933, alt. 1250 m., oak forest undergrowth, common (slender tree or bush 3–4 m. high; small, fleshy purple-black fruit).

Although we have no material with which to compare this collection, according to the description in Loesener's monograph of the Aquifoliaceae it seems to be very close to *Ilex malaccensis* Loes. The fruits are young, but in the one which was cut open there were apparently 14 locules. It differs from the description of the species chiefly in the narrower leaves with longer acumen.

STERCULIACEAE

In the Sterculiaceae of these collections we have the usual widely distributed species of *Abroma*, *Kleinhovia*, *Commersonia*, *Melochia*, *Helicteres* and *Heritiera*. In addition to the common *Heritiera littoralis*, there is a sterile specimen collected near Bernhard Camp, at 400 m. altitude, a specimen of *Pterygota Forbesii*, a sterile collection of *Pterocymbium*, and one of *Tarrietia*. The last genus does not appear in our Index for New Guinean plants, and as far as we know this is the first record of its occurrence in New Guinea. The specimen was determined at Buitenzorg as *Tarrietia Riedeliana* Oliv. Other species of interest are recorded below.

Sterculia Clemensiae sp. nov.

Arbor magna, trunco 37–45 cm. diametro (fide M. S. Clemens); ramulis 10–15 cm. diam., rugosis, novellis dense pubescentibus; foliorum petiolis 4–7 cm. longis, circiter $1/3$ longitudinem laminae aequantibus dense ad-

presso-tomentosis; laminis \pm orbicularibus (omnibus fractis), 12–20 cm. longis latisque, basi cordatis, sinu 0.5–2 cm. alto, 2–4 cm. lato, apice non viso, supra primum consperse stellato-pilosulis deinde costa nervisque pilosulis ceterum glabris, subtus \pm dense pilosulis, pilis stellatis et interdum simplicibus intermixtis, basi 7-nerviis, praeter basales nervis lateralibus utrinsecus \pm 5 (foliis fractis) angulo \pm 45° impositis utrinque prominulis, venis transversis perspicuis, reticulatione sub lente utrinque manifestis; inflorescentiis e ramulis sub apice orientibus, \pm 20 cm. longis, dense stellato-tomentellis, pedunculo 3–5 cm., ramis 3–5 cm., pedicellis 2–3 mm. longis; floribus parvis, tantum δ visis; calyce campanulato in sicco 3 mm. longo, intus dense hirtello, tubo 2 mm., lobis 1 mm. longis triangularibus acutis; columna \pm 1.4 mm. longa, apice penicillata, antheris 5 parallelis in annulum dispositis; mericarpio immaturo, subellipsoideo, $3.5 \times 2.5 \times 2$ cm., apice subapplanato subapiculato haud producto, extus primum stellato-pubescente deinde glabrato, intus \pm dense stellato-hirtello; seminibus immaturis atro-fuscis.

NORTHEAST NEW GUINEA: Morobe District, Lae, *Clemens* 10452 (TYPE), 10466, July 1939, in brush near Busu River (big tree, trunk 15 to 18 inches in diameter; inflorescence brick-red-purple; fruits pale yellowish green).

Sterculia Clemensiae appears to belong in the same group with *S. comosa* Wall. Both have very small flowers. The latter however has a shorter smoother pubescence on the lower surface of the leaves giving them a grayish color. It has been reported from Amboina, the Celebes, and Key Islands.

Sterculia ocinocarpa F. v. Muell. & Forbes, *Victoria Nat.* 3: 48. 1886; Mildbr. Bot. Jahrb. 62: 355. 1929; vel aff.

NETHERLANDS NEW GUINEA: Bernhard Camp, Idenburg River, *Brass & Versteegh* 14102, April 1939, alt. 70 m., occasional in primary forest on edge of flood plain (tree about 30 m. high, 58 cm. diameter; bark 12 mm. thick, black-brown, fairly smooth; wood light brown; flowers yellow).

BRITISH NEW GUINEA: Palmer River, 2 miles below junction Black River, *Brass* 7348, July 1936, alt. 100 m., common canopy tree of lower clayey ridges (\pm 30 m. high; trunk buttressed and covered with gray lenticellate bark; leaves crowded at the apex of the thickened branchlets; fruit close below the leaves on peduncles 20–25 cm. long).

Among the Papuan species these two collections are closest to this species and possibly identical with it. In any case it seems best to point out the differences or variations. Mr. A. W. Jessep, Director of the Melbourne Botanic Gardens and National Herbarium, very kindly sent us a photograph of the type and a fragment of the leaf for comparison. The texture of the leaf is very similar to that of *Brass* 7348 but the pubescence is much finer and sparser. The stellations are minute. The rays of those on the *Brass* specimen are at least five times as long as those in the Forbes collection. Again, in the original diagnosis the fruitlet is described as being about four times longer than broad; in the photograph, however, there is one scarcely twice as long as broad. The fruitlet of the *Brass* collection is approximately $8 \times 5 \times 4.5$ cm., the seeds are olive brown and the surface is reticulate (the other seeds of *Sterculia* species in the herbarium are black; possibly these are not ripe). The collection, *Brass*

& *Versteegh* 14102, has only very young leaves and flowers. Most of the inflorescences (up to 20 cm. long) appear to be sessile or almost so at the apices of short shoots 3–6.5 cm. long; rhachis, branches, branchlets, pedicels, and flowers are all spreading-hirtellous with hairs \pm 1 mm. long; ♂ FLOWER: calyx-tube 3 mm. long, puberulous inside, lobes 1.3 mm. long, ovate, acute, finely pubescent on the upper surface; staminal column 2 mm. long, anthers 5 (4–6), annular; ♀ FLOWER: larger than the staminate and terminal on the branches; calyx-tube 4 mm. and lobes 1–1.5 mm. long, pubescent as in the ♂ flower; ovary 3-lobed, \pm 1.5 mm. long, densely hairy, style 1 mm. long, pubescent, stigma capitate. This collection is myrmecophilous.

Sterculia Shillinglawii F. v. Muell. Australas. Jour. Pharm. (Feb.) 1887.

Sterculia Conwentzii K. Schum. Bot. Jahrb. 9: 208. (Nov.) 1887.

Sterculia multinervia Rech. Rep. Sp. Nov. 9; 184. 1912.

BRITISH NEW GUINEA: Lower Fly River, east bank opposite Sturt Island, *Brass* 8089, Oct. 1936, rain forest, on outer ridges (common canopy tree; stem with well developed plank-buttresses; bark gray-brown; flowers yellow-brown, galled flowers pink; fruit red, mericarps narrow and recurved).

NORTHEAST NEW GUINEA: vicinity of Kajabit, Markham Valley, *Clemens* 10557, 10857bis, August 1939, alt. \pm 240 m.

BISMARCK ARCHIPELAGO: New Britain: near Blanche Bay, *Parkinson* (TYPE of *S. Shillinglawii*); vicinity of Rabaul, *Kanehira* 3994, *Waterhouse* 424 (large spreading tree, excellent for shade; white flowers; striking red seeds in open fruit).

SOLOMON ISLANDS: Guadalcanal: Berande River, *Kajewski* 2411, sea level, rain forest (a medium-sized buttressed tree; pod red outside, salmon-colored inside, seeds green. A person recovering from a long illness, such as fever, is given a tonic made from the bark of this tree pounded and mixed with water). San Cristoval: Wainamura, *Brass* 2843, Sept. 1932, lowland rain forests, not common (small tree with thick, gray, fairly smooth bark; leaves stiff, glaucous below, midrib and main nerves brown on lower surface; flower yellowish green with red throat, the narrow lobes arched and inflexed).

Mildbraed, in his work on the Sterculiaceae of New Guinea, Bot. Jahrb. 62: 347–367, 1929, hesitated to reduce *S. Conwentzii* K. Schum to *S. Shillinglawii* F. v. Muell., although admitting *S. multinervia* Rech. as a synonym. We are indebted to Mr. Jessep for a photograph and fragment of the type of Mueller's species, the isotype of K. Schumann's species at the Kew Herbarium has been examined by the senior author. There seems to be no doubt that *S. Shillinglawii* is the oldest name for this apparently fairly widespread species. Needless to say, there is some variation in the specimens, but not enough to be of specific value.

Sterculia porphyroclada sp. nov.

Arbor \pm 20 m. alta; trunco \pm 20 cm. diam.; ramulis novellis 2–2.5 mm. diam., purpureis in sicco longitudinaliter ruguloso-sulcatis, annotinis 4.5 mm. diam., lenticellatis rimosis, sparsim patenti-hirsutis; foliorum petiolis 1.5–6.2 cm. longis, circiter 1/4 longitudinem laminae aequantibus patenti-hirsutis; laminis oblongo-ellipticis, 10–24 cm. longis, 5–11.5 cm. latis, basi paululo retusis vel rotundatis vel obtusis, apice acuminatis, acumine 1–2 cm. longo, obtusiusculo, supra costa et nervis \pm dense stellato-pilosis ceterum fere glabris, subtus stellato-pilosis, ima basi tri-

nerviis (in foliis majoribus subquinenerviis), nervis lateralibus utrinsecus 10–13 marginem versus arcuatim conjunctis, supra distincte manifestis, subtus prominentibus, venis transversis prominulis, reticulatione ultima supra densissima sub lente distincte manifesta, subtus haud conspicua; inflorescentiis non visis; axi in fructu \pm 5 cm. longo, 4 mm. diametro; mericarpiis \pm 9 cm. longis, 2 cm. diametro, subfalcatis, apicem versus paulo angustatis, apice acutiusculis, extus brevissime et densissime ferrugineo-stellato-tomentellis, intus stellato-pilosulis; seminibus pluribus (8 in uno maricarpio) in sicco atrobrunneis, circiter 15 mm. longis et 7–9 mm. crassis.

NETHERLANDS NEW GUINEA: 6 km. southwest of Bernhard Camp, Idenburg River, *Brass* 12765 (TYPE), February 1939, alt. 1200 m., occasional in rain-forest (subsidiary tree 20 m. high and 20 cm. diameter; fruit orange-red, seeds white).

The species appears to be related to *S. malacophylla* K. Schum. It has longish somewhat stiff hairs on the branchlets and petioles, and 4-pronged stellate hairs on the lower surface of the leaves; however, the hairs are not at all crowded and could scarcely be regarded as sub-tomentose, also they are harsh to the touch rather than soft; the bark on the younger branchlets is dark purple, not yellowish gray; and the leaves have 10–13 pairs of veins as compared with 7–8 in *S. malacophylla* K. Schum.

Sterculia ampla Baker f. Jour. Bot. 61. Suppl.: 5. 1923; White, Jour. Arnold Arb. 10: 240. 1929.

Sterculia coggigria Mildbraed, Bot. Jahrb. 62: 357. 1929.

BRITISH NEW GUINEA: Western Division: Oriomo River, Wuroi, *Brass* 5785, Jan.-Mar. 1934, riverine rain-forest (common erect sparsely branched tree up to about 15 m. high; leaves clustered at branch tips; large red fruit, seeds black); Lake Daviumbu, Middle Fly River, *Brass* 7711, 7785, common in rain-forest (substage or lesser canopy tree; flowers brown-green).

In our herbarium is an isotype of *S. coggigria* Mildbr. which we are unable to distinguish from the earlier described *S. ampla* Baker f. Again, judging by the specimens *Kanehira* & *Hatusima* 11884, 12395, we are inclined to believe that *S. gigantifolia* sensu Kaneh. & Hatus. in Bot. Mag. Tokyo 55: 389. 1941, also belongs here. The stipules are somewhat larger and coarser than in the *Brass* collections, and the pubescence varies. It might be worth noting that the inflorescence of *Kanehira* & *Hatusima* 11884 is 60 cm. long.

Sterculia quadrifida R. Brown in Benn. Pl. Jav. Rar. 233. 1844; F. M. Bailey, Queensl. Fl. 1: 136. 1899; Queensl. Agric. Jour. 22: 147. 1909; C. T. White, Proc. Roy. Soc. Queensl. 33: 152. 1921.

BRITISH NEW GUINEA: Western Division: Mabaduan, *Brass* 6480, 6503, common in monsoon forests on granite slopes (tree to 10 m. high; branches flatly spreading; bark rough, brown; fruit generally 4-lobed, red, somewhat rugose; seeds a beautiful velvety-black); Wassi Kussa River, Tarara, *Brass* 8414, common in dry brushy rain-forests (tree 14–15 m. high; bark gray, lenticellate, somewhat scaly; leaves gray underneath; fruit orange-red, seeds velvety-black).

Previously reported by F. M. Bailey from Boku, Papua. These specimens are a reasonably good match for *Brass* 2378 collected on the Mow-

bray River, Queensland. All are finely and closely velvety-tomentose on the under surface of the leaves. In the Queensland collection the fruit is less pointed at the base, a minor difference. There is considerable variation in the length and breadth of the leaves, those of *Brass* 8414 are oblong-lanceolate, 7.5–16 cm. long, 3.2–5.3 cm. wide; in the other specimens the leaves are more nearly elliptic or slightly obovate, 5.5–10 cm. long, and 3.5–6 cm. wide.

Keraudrenia J. Gay

Keraudrenia corollata (Steetz) Domin, Bibl. Bot. 22(Heft 895): 974. 1928.

Seringia corollata Steetz in Lehm. Pl. Preiss. 2: 350. 1848.

NETHERLANDS NEW GUINEA: Waren, 60 miles south of Manokwari, *Kanehira & Hatusima* 12963, 13205, March, 1940, alt. 200–300 m., on grassy hill (plant 1 m. tall; flower pink).

This plant agrees very well with a number of Queensland collections placed in this species. *Keraudrenia lanceolata* has been reported once from northern New Guinea, but this seems to be the first record of this species from the island.

PASSIFLORACEAE

Passiflora Linnaeus

Passiflora moluccana Blume Bijdr. Fl. Nederl. Ind. 938. 1826; DC. Prodr. 3: 323. 1828; Rumphia 1: 169. *t.* 51. 1835; Koorders Exkursjonsfl. Java 2: 638. 1912; vel aff.

SOLOMON ISLANDS: Bougainville: Kugumaru, Buin, *Kajewski* 1913, July 1930, alt. 150 m., rain forest (common vine on rain forest trees; fruit green, 4.2 cm. long, 4 cm. diameter); Koniguru, Buin, *Kajewski* 2076, October 1930, alt. 950 m., rain forest (vine; fruit globular, 3.9 cm. diameter, slightly flattened top and bottom). Ysa bel: Tasia, *Brass* 3283, Dec. 1932, coastal rain forests (large climber; leaves stiff, with pale nerves, glands pale brown; immature fruit about 2.5 cm. diameter, green).

These specimens differ from the description and plate of this species in having somewhat larger leaves (12–17 cm. long, 5.5–8.5 cm. wide) and globose fruits. Since we have no flowering material it seems best to place it here for the present. *Passiflora moluccana* Bl. is a native of the Moluccas.

Hollrungia K. Schumann

Hollrungia aurantioides K. Schum. Bot. Jahrb. 9: 212. 1888; Merr. & Perry, Jour. Arnold Arb. 24: 210. 1943, op. cit. 29: 160. 1948.

BRITISH NEW GUINEA: Central Division, Mafulu, *Brass* 5239, Sept.-Nov. 1933, alt. 1250 m., on edge of forest clearing, only one example seen (large woody climber; leaves smooth and shining; flowers yellow-green; fruit immature).

Our duplicate specimen had lost all its flowers, but it was finally named with the aid of some flowers from the first set in New York. Now we have one or two collections from each political division of New Guinea, indicating the plant is probably wide-spread over the island, but apparently not plentiful anywhere.

GENTIANACEAE

Nymphoides Hill.

Nymphoides hydrocharoides (F. v. Muell.) O. Ktze. Rev. Gen. 2: 429. 1891 (as *Nymphodes hydrocharodes*).

Villarsia hydrocharoides F. v. Muell. Fragm. Phytogr. Austr. 6: 139. 1868.

Limnanthemum hydrocharoides F. v. Muell. ex Bentham Fl. Austr. 4: 380. 1868; F. M. Bailey, Queensl. Fl. 3: 1030. 1900.

BRITISH NEW GUINEA: Wuroi, Oriomo River, *Brass 5871*, Jan.-Mar. 1934, alt. 20 m., plentiful in small pools of a little creek on savannah (leaves reddish underneath; flowers orange-colored).

Through the co-operation of Mr. C. T. White of Brisbane, a duplicate of *Brass 5871* was sent to Melbourne, where it was checked with the type of Mueller's species by Mr. J. H. Willis, who found it to match very well indeed. This appears to be the first record of this Australian species from New Guinea. Its most striking character is found in the comparatively large and minutely pubescent seeds.

Nymphoides parvifolium (Griseb.) O. Ktze. Rev. Gen. 2: 429. 1891 (as *Nymphodes parvifolium*).

Limnanthemum parvifolium Griseb. in DC. Prodr. 9: 141. 1845; F. M. Bailey, Queensl. Fl. 3: 1029. 1900.

BRITISH NEW GUINEA: Mabaduan, *Brass 6534*, April 1936, common in shallow grassy rain pools in savannah forests (very small white flowers). Previously reported from India, Siam, Ceylon, the Malay Peninsula, and Queensland.

SOLANACEAE

In the Solanaceae, as in so many other instances, we have very little authentic material for comparison. Many of our collections differed so widely from the descriptions of the species already reported for that island that we have described them as new. Following the latest work on the Solanaceae by Mr. C. V. Morton, Contrib. U. S. National Herbarium, 29: 54, 55. 1944, we have treated *Lycianthes* as a section of the genus *Solanum*.

Solanum leptacanthum sp. nov.

Frutex \pm 1 m. altus; ramulis teretibus, 2-2.5 mm. diametro, consperse stellato-pubescentibus, sparsim aculeatis, aculeis tenuissimis, usque 7 mm. longis basim versus 0.5 mm. diametro, internodiis 2.5-3 cm. longis; foliis alternis membranaceis, lanceolatis, 9-15 cm. longis, 2.5-4.5 cm. latis, apice acuminate, acumine \pm 2 cm. longo, basi interdum inconspicue inaequaliteralibus interdum valde obliquis, anguste cuneatis, margine subintegris vel undulatis vel leviter angulatis, nonnumquam non profunde lobatis, utrinque costa et interdum venis primariis aculeatis, aculeis gracilibus 2-8 mm. longis (2-14 per costam), supra fere glabris et olivaceis, subtus leviter pallidioribus et consperse stellato-pubescentibus, venis primariis utrinsecus 5-7 utrinque manifestis, oblique adscendentibus deinde arcuatis, secundariis \pm manifestis; petiolo 4-9 mm. longo, sparsim stellato-pubescente; inflorescentiis \pm 20-floris, minute stellato-pubescentibus, pedunculo 3-10 mm. longo, rhachi brevi, pedicellis 7(-30 in fructu interdum basi aculeatis) mm. longis; calyce cupulari, 1 mm. longo, 5-dentato, dentibus

minutis; corolla 6 mm. longa, tubo 1 mm. longo, lobis lanceolatis, intus glabris; filamentis brevissimis, antheris 4 mm. longis, anguste lanceolatis, apicem versus angustatis, poris apicalibus minimis; ovario ovoideo, 1 mm. longo, stylo gracili, 4 mm. longo; fructibus ovoideis, 1.8 cm. longis, 1.5 cm. diametro, seminibus ± 20 , oblique reniformibus, $6 \times 4.5 \times 0.6$ mm., minute reticulatis.

BRITISH NEW GUINEA: Central Division, Ononge Road, Dieni, *Brass 3814* (TYPE), April 1933, alt. 500 m., in rain forest (one plant seen; shrub 1 m. with terminal flat-spreading branches; flowers pink; fruit broadly ovoid, orange-yellow, ± 1.8 cm. long, 1.5 cm. diameter).

In addition to the above cited collection, we have a specimen from Ihu, Vailala River, *Brass 972*, which agrees very closely with the type except that the calyx has very definite lobes and is about 3 mm. long, the fruit is very much like that described above in color and size of seeds, the plant is described as a weed in rain forest clearings. Unfortunately there are not very many flowers on any of the specimens, in fact only about a single open one on each, and several buds on the type, hence it is difficult to estimate the amount of variation in the character of the calyx.

Solanum oligolobum sp. nov.

Frutex magnus; ramulis teretibus 3–6 mm. diametro, aculeatis, primum stellato-tomentosis demum paullo glabris, pilis sessilibus vel stipitatis apice stellatis grossis, flavidis, aculeis \pm crebris, rectis, 5–10 mm. longis basi 1–2 mm. latis, internodiis 2.5–5.5 cm. longis; foliis alternis vel superioribus plerumque geminatis vel parum inter se distantibus, paullo inaequalibus, tenuiter chartaceis fragilibus, ambitu lanceolatis, apice acutis vel sensim acuminatis, basi inaequilateralibus, obtusis, margine grosse 3–4-lobatis (lobis obtusis vel acutis interdum mucronatis, sinibus plerumque late subrotundatis in foliis minorum fere planis), utrinque costa et venis primariis (utrinsecus ± 6 inconspicuis) aculeatis (aculeis paucis usque 1.5 cm. longis), supra \pm dense tomentosis (pilis stellatis stipitatis sessilibusque) interdum consperse glandularibus, atro-olivaceis, subtus dense tomentosis et glandularibus paullo pallidioribus, lamina majorum 11–21 cm. longa, 4–13 cm. lata, petiolo 3–5 cm. longo, tomentoso et aculeato (aculeis usque 2.2 cm. longis), minorum 5–13 cm. longa, 2–5.5 cm. lata, petiolo 1.5–2 cm. longo; inflorescentiis dense tomentosis, primum fere terminalibus, serius in latus coactis, ± 12 -floris; pedunculo 2–10 mm. longo, rhachibus simplicibus vel furcatis, pedicellis 1 (–1.5 in fructu) cm. longis interdum aculeatis, aculeis paucis usque 4 mm. longis vel nullis; calyce 3.5–4 mm. longo, campanulato, 5-lobato, lobis in dentes lineari-subulatos vix 1.5 mm. longos abrupte angustatis; corolla violacea, rostrata, tubo ± 2 mm. longo, lobis 8–9 mm. longis, extus margine lato excepto stellato-tomentosis; staminibus 5 (interdum 6), circiter 1 mm. corollae basim supra insertis, filamentis vix 2 mm. longis, antheris 3–3.5 mm. longis, apicem versus angustatis; ovario ovoideo, 1.5 mm. longo, apicem versus glandulis paucis breviter stipitatis instructis, stylo ± 4 mm. longo; fructibus ± 1 cm. diametro, glabris, seminibus numerosis, $2.5 \times 2 \times 0.4$ mm., minute reticulatis.

NETHERLANDS NEW GUINEA: 9 km. NE. of Lake Habbema, *Brass 10876* (TYPE), Oct. 1938, alt. 2650 m., sunny situation at base of landslip (large shrub with violet flowers).

In the outline of the leaves and the straight prickles this species suggests *S. Gibbsiae* J. R. Drummond; in *S. oligolobum*, however, the leaves are very much larger, the prickles fewer, the tomentum denser and, particularly on the lower leaf-surface, mixed with stipitate glands, the inflorescence compound, and the fruit has many more seeds. The stalked coarse hairs forming a thick and loose tomentum give the impression of a thicker leaf than where the hairs are sessile (and usually finer); at the same time both leaves may be similar in texture and thickness.

Solanum trichostylum sp. nov.

Frutex usque 2 m. altus; ramis sensim glabris, \pm 4 mm. diametro; ramulis novellis dense tomentosis (pilis stellatis, parvis, sessilibus), aculeolatis (aculeolis vix 2 mm. longis, basi 2 mm. latis, lateraliter compressis), \pm 2 mm. diametro, internodiis 1–5 cm. longis; foliis alternis, firme chartaceis, 3–9 cm. longis, 1.5–4 cm. latis, ovatis, apice acuminatis vel acutis, basi saepe inaequilateralibus, cuneatis, margine subintegris vel repandis vel interdum sublobatis, utrinque costa et interdum venis aculeatis (aculeis remotis paucisque 2–6 mm. longis, rectis) vel fere inermibus, supra olivaceis et sparsim, subtus subflavidis et dense stellato-tomentosis, venis primariis utrinsecus 6–8 supra impressis, subtus prominulatis, rete supra impresso subtus prominulente; petiolo 1–2 cm. longo, dense stellato-tomentoso interdum 1–3-aculeato; inflorescentiis 6–10-floris, dense stellato-tomentosis in sicco subflavidis, primum fere terminalibus serius in latus coactis; pedunculo 5–10 mm. longo, rhachi brevi, pedicellis \pm 1 cm. longis; calyce 4 mm. longo, subcampanulato, 5-lobato, lobis vix 2 mm. longis, subtruncatis, apiculatis, apiculo 0.5 mm. longo; corolla 5-lobato, circiter 1 cm. longo, lobis late ovatis apice leviter cucullatis, utrinque stellato-pubescentibus margine tantum glabris; staminibus supra corollae basim 1.5 mm. insertis, filamentis 2 mm. longis, antheris lanceolatis, basi 2 mm. apice 0.6 mm. latis, poris apicalibus parvis extrorsis; stylo 7 mm. longo, in dimidio inferiore stellato-pubescente; ovario subgloboso 1.5 mm. diametro, glabro; fructibus \pm 1 cm. diametro, apiculatis, seminibus oblique subreniformibus, $4 \times 3.5 \times 0.5$ mm., margine minute reticulatis.

BRITISH NEW GUINEA: Central Division, Mount. Tafa, *Brass 4934* (TYPE), Sept. 1933, alt. 2400 m., plentiful on clearings in the forest in the vicinity of the road (slender shrub up to 2 m. high; branches, petioles, peduncles, and pedicels purple-tinged; pale dull leaves; bright purple flowers; ripe fruit yellow); Wharton Range, Murray Pass, *Brass 4539*, July 1933, alt. 2840 m., a weed plant on forest borders damaged by fire (sparsely branched shrub 1–1.5 m. high; leaves pale; corolla purple, anthers bright yellow; soft, globose, black fruit about 1 cm. diameter).

Solanum torvoideum sp. nov.

Frutex altus vel arbor parva; ramulis teretibus \pm 5 mm. diametro, novellis grossissime stellato-tomentosis deinde glabris, pilis stipitatis vel sessilibus grossis flavidis, aculeis paucis, vix 1 mm. longis, inconspicuis, internodiis 2.5–5.5 cm. longis; foliis inermibus alternis vel interdum superioribus geminatis (uno minore), fragilibus, tenuiter chartaceis ambitu lanceolatis vel lanceolato-ellipticis (5.5 –) 7–16.5 cm. longis, (1.5 –) 3–9 cm. latis, basi tantum leviter inaequalibus obtuse cuneatis, apice longe acutis, margine sinuatis vel irregulariter et remote lobatis, supra fulvo-brunneis, subtus leviter pallidioribus, utrinque densissime stellato-tomentosis, pilis saepissime stipitatis, venis primariis utrinsecus \pm 5, supra

manifestis, subtus latioribus et prominulis, oblique adscendentibus marginem versus arcuatis, rete laxo tantum subtus in foliis majoribus manifesto; petiolo 1.2–2.5 cm. longo densissime stellato-tomentoso; inflorescentiis (in fructu 7–8 cm. longis) primum fere terminalibus serius in latus coactis, \pm 20-floris, dense stellato-tomentosis, serius glabris; pedunculo 7–15 mm. longo, furcato, rhachibus et pedicellis (1–2 cm. longis) etiam \pm glandulosis; calyce campanulato, tubo 2 mm. longo, lobis 4 mm. longis, lanceolatis apice 2 mm. subulatis, corolla \pm 10 mm. longa, lobis intus apice tantum pubescentibus leviter cucullatis vel apiculatis; staminibus 1 mm. supra corollae basim insertis, filamentis 1.5 mm. longis, antheris 4 mm. longis, lanceolatis sursum angustatis; ovario subgloboso minute glanduloso, stylo 6 mm. longo; fructibus globosis, \pm 1 cm. diametro glabris; seminibus numerosis, $2 \times 1.8 \times 0.5$ mm., ovalibus, fere levibus.

BRITISH NEW GUINEA: Central Division, Mafulu, *Brass 5411* (TYPE), Oct. 1933, alt. 1250 m., forest regrowths (tall bush or small tree; very few small prickles on branches; flowers white; fruit orange-brown).

This collection differs from what we take to be typical *S. torvum* Sw. in the coarse thick tomentum on both surfaces of the leaves which gives the plant a yellowish brown appearance when dry rather than pale or cinereous green which is characteristic of typical *S. torvum* Sw.; the leaves also are only slightly inequilateral at the base, and the pedicels are more robust; in the specimens at hand there are also many less flowers in the flower-cluster.

Solanum inaequilaterale Merr. Philip. Jour. Sci. 1, Suppl.: 236. 1906; Enum. Philip. Fl. Pl. 3: 426. 1923.

NETHERLANDS NEW GUINEA: Bele River, 18 km. NE. of Lake Habbema, *Brass 11590*, Nov. 1938, alt. 2200 m., occasional in open grassy second growths (spreading tree 1.5–2 m. high; flowers lavender; fruit yellow).

This specimen is a very good match for the Philippine material of this species, and both come from the same altitude.

Solanum Schefferi F. v. Mueller, Descr. Notes Papuan Pl. 1: 44. 1876.

Solanum incanum Scheffer, Ann. Jard. Bot. Buitenz. 1: 39. 1876, non Linn.

Solanum smilacocladium Bitter, Bot. Jahrb. 55: 79. 1917.

In citing the Buitenzorg Herbarium specimen *no. 9853!* (sub. nom. *S. incanum* Scheff.) we believe that Bitter was citing the type of Scheffer's *Solanum incanum*, hence the first valid name for the species is *S. Schefferi* F. v. Muell., rather than *S. smilacocladium* Bitter, even though the description is emended.

Solanum heteracanthum sp. nov.

Planta suffruticosa \pm 1.5 m. alta; ramis aculeatis et fere glabris, ramulis primum pilis stellatis dense tomentosis demum glabris, aculeatis, aculeis 5–7 mm. longis, ad basin 5 mm. attingentibus, recurvis, a latere compressis; foliis alternis vel saepe ad nodos binis et inaequalibus, 5–12.5 cm. longis, 1.8–5 cm. latis, margine angulato-sinuatis vel interdum subintegris, basi plerumque inaequaliter cuneatis vel obtusis, apice longe et sensim acuminatis, supra maturis in sicco atro-olivaceis glabris, novellis costa et venisque stellato-pubescentibus, subtus fulvo-cinerascentibus dense stellato-tomentosis, costa venisque consperse aculeatis, aculeis paucis rectis

vel leviter recurvis usque 9 mm. longis ad basin 1–1.5 mm. latis; petiolo 7–9 mm. longo, tomentoso; inflorescentiis extra-axillaribus usque 14-floris, pedunculo \pm 5 mm. longo, furcato, rhachibus 2–5 mm. longis, pedicellis confertis, 7–10 (–17 in fructu) mm. longis apicem versus incrassatis et angulatis, sicut pedunculo et rhachibus stellato-pubescentibus; alabastris dense stellato-tomentosis; calyce campanulato, tubo vix 2 mm. longo, lobis 3 mm. longis, abrupte obtusis apiculatis; corolla rotata, \pm 11 mm. longa, 5-lobata, lobis lanceolatis extus dense stellato-tomentosis in dimidio inferiore membranis glabris conjunctis et marginatis, intus in parte superiore venae mediae interdum pilis stellatis obsitis; staminibus 5, \pm 1.5 mm. supra corollae basin insertis, filamentis 2 mm. longis glabris, antheris anguste lanceolatis 6 mm. longis basi 1 mm. latis, fere a basi subcordata apicem versus sensim angustatis, poris apicalibus parvis; ovario ovoideo 1 mm. longo, glabro, stylo 8 mm. longo; fructu immaturo subgloboso, 1 cm. diametro, seminibus \pm 16 reniformibus lateraliter compressis, 4×3 mm., margine 0.6 mm. circumdatis, minute reticulatis.

NETHERLANDS NEW GUINEA: 9 km. NE. of Lake Habbema, *Brass 10764* (TYPE), Oct. 1938, alt. 2700 m., rain forest of valley bottom (weak shrub 1.5 m. high, in a native clearing; flowers purple; fruit unripe); Bele River, 18 km. NE. of Lake Habbema, *Brass 11505*, Nov. 1938, alt. 2200 m., scrambling on an open landslip (flowers purple; fruit immature).

Among the descriptions of the New Guinean species of *Solanum* this is perhaps related to *S. Gibbsiae* J. R. Drummond; but in the latter the spines are straight, and the inflorescence 1–3-flowered. Among the species which we have seen, it is most like *S. dimorphispinum* C. T. White of Queensland. The latter, however, is larger in most dimensions, the leaves are only repand, the inflorescence is much more open, and the pubescence more compact. Our species seems best characterized by the strongly recurved prickles with broad bases on the branchlets, the angled sinuate margins of the leaves, the longer and practically straight prickles with narrow bases on the leaves (on the midrib and main primary veins of the upper surface, usually confined to the midrib on the lower surface), and the rather compact inflorescence; whether the thin margin of the seed is a good diagnostic character or only on account of its immaturity we cannot say.

Solanum acuminatissimum sp. nov.

§ LYCIANTHES

Frutex 60 cm. alta; ramulis sparsim pilosulis vel puberulis, internodiis 2–3.5 cm. longis; foliis geminatis inaequalibus, tenuiter chartaceis; majoribus 6.5–16 cm. longis, 2.8–7 cm. latis, ovato-ellipticis utrinque angustatis, basi oblique cuneatis, apice longe acuminatis, acumine 1.2–3 cm. longo, basi 7 mm. lato, lineari-lanceolato \pm falcato, margine undulatis vel subintegris, utrinque glabris, supra olivaceis, subtus pallidioribus, venis lateralibus utrinsecus \pm 6 oblique adscendentibus prope marginem arcuatis, utrinque perspicuis, rete laxo \pm manifesto; petiolo sparsim pilosulo vel puberulo, 1–1.3 cm. longo; foliis minoribus 2–5.5 cm. longis, 1.3–3.5 cm. latis, petiolo 3–5 mm. longo; inflorescentiis axillaribus 2–3-floris, glabris, pedicellis 2–2.5 cm. longis; calyce (cupulari) in fructu patenti, truncato, infra marginem dentibus 3–5 obtusis, 0.5–1 mm. longis, oriundis; baccis globosis, circiter 1 cm. diametro; seminibus satis numerosis, reniformibus, in sicco vix $3 \times 3 \times 1$ mm., distincte reticulatis.

NETHERLANDS NEW GUINEA: 15 km. SW. of Bernhard Camp, Idenburg River, *Brass 12290* (TYPE), Jan. 1939, alt. 1800 m., one example on a small clearing in mossy forest (shrub 60 cm. high; fruit green; pedicels, calyx, and lower surface of leaves tinged with purple).

This species is perhaps best distinguished by the thinly chartaceous \pm sinuate-margined larger leaves with a long slender somewhat falcate acumen, the few-flowered inflorescence, and the thin calyx. It is very much like *Solanum banahaense* Elmer in that both have calyces with minute teeth (or lobes) developing just below the margin. In the Philippine material (which also has entire leaves of firmer texture) this character appears to be fairly constant, the teeth originating from 4 angles or ribs; in the New Guinean collection the character is variable, sometimes only 3 teeth are developed, and sometimes 5.

Solanum multifolium sp. nov.

§ LYCIANTHES

Frutex gracilis, 2–3 m. altus; ramulis 1–2 mm. diametro, teretibus, pubescentibus, pilis brevibus apice incurvis, internodiis 0.7–3 cm. longis; foliis membranaceis, plerumque geminatis interdum solitariis; majoribus (1.2–)4–9 cm. longis, 1.5–3.7 cm. latis, lanceolatis, utrinque angustatis, basi cuneatis inconspicue obliquis, apice acutis interdum obtusiusculis vel obtusis, margine integris, supra glabris, subtus costa et venis tantum pilis paucis insertis, venis primariis utrinsecus 5–7 supra inconspicuis, subtus manifestis, rete sub lente laxo manifesto; petiolo (1.5–)4–7 mm. longo sicut ramulis adscendenti-pubescente; foliis minoribus 0.5–1.5 cm. longis, 0.4–0.8 cm. latis, lanceolato-ovatis vel suborbicularibus, obtusis; petiolo brevissimo vel usque 2.5 mm. longo; floribus solitariis vel geminatis, glabris, pedicellis 0.7–1.8 cm. longis, alabastro uno tantum viso, 5 mm. longo; calyce cupulari, 2.5 mm. longo, apice 3 mm. diametro; corollae lobis 5, apice leviter cucullatis et puberulis; filamentis brevibus, antheris 3 mm. longis, lineari-lanceolatis; pistillo minuto; fructibus globosis, \pm 7 mm. diametro, seminibus \pm 15, 2.5–3 mm. longis latisque, 1.5 mm. crassis.

NETHERLANDS NEW GUINEA: 6 km. SW. of Bernhard Camp, Idenburg River, *Brass 12907* (TYPE), Feb., 1939, alt. 1150 m., common in a rain forest gully (very slender tree 2–3 m. high; fruit red; one white flower-bud).

A species easily recognized by its relatively small and very thin leaves, short internodes, and mostly solitary flowers.

Solanum belense sp. nov.

§ LYCIANTHES

Frutex parvus; ramis cinereis, glabris, ramulis novellis dense puberulis demum glabris, 1.5–3 mm. diametro, internodiis 1.5–3 cm. longis; foliis tenuiter chartaceis, plerumque geminatis suboppositis, interdum solitariis, majoribus 4.5–15.5 cm. longis, 2.5–5.5 cm. latis, late lanceolatis, apice obtuse vel acute acuminatis, basi oblique cuneatis, margine integris, utrinque glabris, novellis subtus costa venisque puberulis mox glabris, venis primariis utrinsecus 6–8 supra manifestis, subtus prominulis, adscendentibus, marginem versus arcuatis, rete laxo supra inconspicuo subtus distincte manifesto; petiolo 0.5–1.5 cm. longo, \pm puberulo; foliis minoribus 1–3.5 cm. longis, 0.5–1.8 cm. latis, lanceolatis vel elliptico-lanceolatis, basi plerumque obliquis, apice obtusis vel acutis, glabris, venis primariis \pm 4; petiolo 3–5 mm. longo; inflorescentiis inter bases petiolorum insertis, glabris; floribus solitariis vel 2–6-fasciculatis, fasciculis interdum

pedunculo brevissimo vel pulvillo insertis, pedicellis usque 2 cm. longis; calyce cupulari, 3 mm. longo, apice 3 mm. diametro; corollae tubo 5 mm. longo, lobis \pm 1 cm. longis, 4 mm. latis, acutis, extus apice cucullato et margine dense puberulis; staminibus tubi corollae apicem prope insertis, filamentis 1.5–2 mm. longis, antheris 3 mm. longis, oblongis apice tantum paullo angustatis; ovario ovoideo, 1.5 mm. longo, stylo 7 mm. longo; fructu non viso.

NETHERLANDS NEW GUINEA: Bele River, 18 km. NE. of Lake Habbema, *Brass 11223* (TYPE), Nov. 1938, alt. 2300 m., Fagaceae forest, common in moist semi-shade (small shrub; pedicel and calyx violet; corolla white).

Only one branch seems to have any perfect flowers, the rest are all staminate; in the latter the filaments are a little longer than in the perfect ones.

Solanum acuminatissimum, *S. belense*, and *S. multifolium* are all closely related. The first appears to be easily separable on its somewhat undulate, long-acuminate leaves, and slightly dentate calyx, the latter character is not present in either of the other species. For the most part, *S. belense* has more pubescent branchlets, entire, narrower and more shortly acuminate leaves, and more flowers in a fascicle. These are fastened to a slight swelling or a very short peduncle situated between the bases of the petioles of each pair of leaves. *Solanum multifolium* has very short internodes, and on the average much smaller leaves than the other two. All three species have thin leaves and calyces, but in the last species the leaves are seemingly more translucent than in the other two.

Solanum rostellatum sp. nov.

§ LYCIANTHES

Planta suffruticosa, \pm 1 m. alta; ramulis teretibus, glabris, 1–3 mm. diametro, novellis dense hirtellis, pilis simplicibus pluri-cellularibus, internodiis 1.5–3 cm. longis; foliis saepe majoribus cum foliis minutis geminatis, majoribus 4–9 cm. longis, 1–3.5 cm. latis, chartaceis, late oblongis vel lanceolatis, basi \pm oblique cuneatis vel obtusis, apice subabrupte acuminatis vel rostellatis, acumine 8–15 mm. longo basi 4–5 mm. lato, integris, in sicco atro-olivaceis, supra glabris, subtus costa et venis primariis \pm hirtellis, venis primariis utrinsecus 5–6 curvatim adscendentibus prope marginem arcuatim conjunctis, rete utrinque manifesto; petiolo 5–9 mm. longo, \pm hirtello; foliis minutis 4–8 mm. longis, 2–4 mm. latis, suborbicularibus, subsessilibus; inflorescentiis axillaribus, 1–2-floris, pedicellis usque 2 cm. longis, sparsim hirtellis vel fere glabris; calyce cupulari, truncato, 2 mm. longo, apice 3 mm. diametro, consperse pilosulo vel glabro; corolla glabra, tubo 2 mm. longo, lobis 5, \pm 5 mm. longis, 1.2–1.5 mm. latis, apice subacutis, margine (in alabastris) minutissime papillatis; filamentis latis et brevissimis, sub apice tubi corollae insertis, antheris lineari-lanceolatis, 4 mm. longis, basi 1 mm., apice 0.5 mm. latis, poris apicalibus parvis; ovario ovoideo, stylo 5 mm. longo; baccis non visis.

BRITISH NEW GUINEA: Central Division, East Mt. Tafa, *Brass 4135* (TYPE), May 1933, alt. 2100 m., common on roadside in tall foothill forest (weak shrub about 1 m. high; leaves dull green on purple petioles; corolla purple, anthers bright yellow).

This species might be compared to *Solanum cladotrichum* Bitt., but the latter is a high-climbing liane with gradually acuminate leaves, considerable pubescence and small flowers; our species is a small shrub with some-

what abruptly acuminate leaves, the pubescence (unbranched hairs) is scanty occurring chiefly on the younger branchlets, the midrib and veins of the lower surface of the leaves, and very few hairs on the pedicels and calyx. The flowers are larger than those described for Bitter's species.

Solanum Rechingeri Witasek, Rep. Nov. Sp. 5: 165. 1908, Denkschr. Math.-Nat. Kl. Akad. Wiss. Wien 89: 602. 1913; Bitter, Bot. Jahrb. 55: 102. 1917.

Lycianthes Rechingeri (Witasek) Bitter, Abhandl. Nat. Ver. Bremen 24: 504. 1920.

SOLOMON ISLANDS: Bougainville: Kugimaru, Buin, *Kajewski* 1800, June 1930, alt. 150 m., rain forest, common (small tree with white trunk; petioles of leaves blue, darker near the base; petals blue, stamens yellow); same locality, *Kajewski* 1863 (fruit 1.4 cm. long, 1.2 cm. diameter, light green-blue when ripe); Siwai, *Waterhouse* 66 (small tree). Guadalcanal: Berande River, *Kajewski* 2388, June 1930, rain forest (small tree up to 10 m. high; purple petals, yellow stamens). Ysaabel: Tiratona, *Brass* 3314, Dec. 1932, alt. 600 m., rain forests, common (slender tree up to 10 m. tall; pale brown bark; small bright red fruits).

This species is closely related to *S. vitiense* Seem. Just about the time of anthesis the flower-bud is 8 mm. long, and 3.5 mm. diameter (in the dried specimen); the calyx is cupular, 2 mm. high, the margin \pm tufted puberulous-ciliolate, as is also the margin of the corolla-lobes; in the full-blown flower the corolla-lobes are about 8 mm. long, the tube 4 mm.; the filaments are 2.5 mm. long, the anthers 3 mm. long; the style 2 mm. long. In *S. vitiense* Seem. the flower-buds are broader in proportion to the length, and the inflorescence does not show any tendency to become racemose in fruit, as is the case in *S. Rechingeri* Witasek. In the latter species the leaf-bases are both symmetrical and unsymmetrical in the specimens cited.

Solanum impar Warburg, Bot. Jahrb. 13: 415. 1891; Bitter, Bot. Jahrb. 55: 109. 1917.

Lycianthes impar (Warb.) Bitter, Abhandl. Nat. Ver. Bremen 24: 504. 1920.

BRITISH NEW GUINEA: Fly River, 528 mile Camp, *Brass* 6796, May 1936, alt. 80 m., climbing on undergrowth trees in the river flood-bank forests (attractive purple flowers and blue fruit in axillary fascicles, fruiting calyx white).

This specimen seems to fit the description of Warburg's species reasonably well; the leaves are chartaceous and vary a little more in size (15–32.5 cm. \times 5–8 cm.), the peduncle does not exceed the length of a centimeter, and the berries are oblong or slightly ovoid (7–8 mm. \times 5 mm.). The calyx is cup-shaped, truncate or slightly undulate, 2–3 mm. high; the corolla tube is about the same length, the lobes 5(–6), about 3.5 mm. long, 1 mm. broad, apex slightly cucullate and very slightly puberulous; filaments inserted near the top of the corolla-tube, 1 mm. long, glabrous, anthers oblong, 2.5 mm. long; pistil sometimes minute (as described in *S. Ledermannii* Bitter) or aborted, or again normal with the style protruding beyond the stamens about 1.5 mm.

PLANTAGINACEAE

Plantago Linnaeus

In van Steenis's article, "On the origin of the Malaysian mountain flora," Bull. Jard. Bot. Buitenz. III. 13: 235. 1934, we find concerning *Plantago*

that "no species seems to be indigenous in Malaysia." Since then four species have been collected in the high mountains of New Guinea during the Archbold Expeditions. The first, from British New Guinea, reported by Pilger in 1935, was originally described from New Zealand. Now this same species (at least in a broad interpretation) and three others also with southern affinities are reported here.

Plantago trichophora sp. nov.

§ MESEMBRYNIA

Planta, ut videtur perennis, acaulis vel caudex brevis crassiusculus; foliis fragilibus, usque 13 cm. longis (parte superiore 3–7 cm. longa, 0.5–1 cm. lata), deorsum sensim angustatis in petiolum 2–5 cm. longum, 1.5–2 mm. latum, crispe pilosum, transeuntibus, basi paulo dilatatis ibique lana longa fulva involutis, apicem versus angustatis, apice ipso obtusiusculis, integris, trinerviis, supra consperse pilosis vel fere glabris, pilis longis, subtus nervis sparsim, costa praecipue basin versus dense pilosis; inflorescentiis usque 20, pedunculis longitudine variantibus (7–17 cm. longis), teretibus, pilosis, pilis longis, basin versus pedunculi conspersis, crispis, \pm patentibus, apicem versus infra spicam adscendentibus et densis; spica 2–4 cm. longa, 5 mm. lata, densa; bracteis vix 2 mm. longis, late ovatis, obtusis, obtuse carinatis, glabris, margine sparsim ciliatis, intus basi \pm pilosis; sepalis 3 mm. longis, posticis ellipticis, valde concavis, apice vix angustatis, carina crassiuscula prominula, anticis paulo angustioribus, parum inaequilateralibus, glabris vel interdum sparsim et consperse ciliolatis; corollae tubo 2 mm. longo, lobis 1.5 mm. longis, rotundato-ovatis; capsulis ellipsoideis, apice ad basim styli induratis, circiter 4 mm. longis (parte superiore 2.5–3 mm., inferiore 1.5 mm.), seminibus 4–5, fuscis, ambitu ovato-oblongis, crassis, fere 2 mm. longis, subtiliter punctatis, facie hili convexis.

BRITISH NEW GUINEA: Mount Albert Edward, *Brass* 4352 (TYPE), June 1933, alt. 3680 m., common; wet slopes of alpine grasslands (leaves flat, spreading, concave, margins red).

This plant belongs to the section MESEMBRYNIA Decaisne. From the descriptions at hand we are unable to suggest a closely related species.

Plantago lanigera Hook. f. Handb. New Zeal. Fl. 227. 1864; Pilger, Bot. Jahrb. 67: 236. 1935; Pflanzenr. 102(IV. 269): 120. 1937.

NETHERLANDS NEW GUINEA: Lake Habbema, *Brass* 9457, Aug. 1938, alt. 3225 m., filling the spaces between scattered grass-tussocks on marshy slopes; 11 km. northeast of Wilhelmina-top, *Brass & Meyer-Drees* 9819, Sept. 1938, alt. 3400 m., alpine grassland, occasional flat rosettes on sandy banks of a stream; 2 km. east of Wilhelmina-top, *Brass & Meyer-Drees* 10220, Sept. 1938, alt. 3800 m., alpine grassland, scattered along banks of a stream.

In reporting *Brass* 4646, Pilger pointed out that it varied somewhat from the New Zealand material. These collections vary even more, particularly in size. The plants are 4.5–16.5 cm. in diameter with leaves 1.5–8 cm. long, and 0.4–1.8 cm. broad; the pubescence of the leaves is variable, in some plants appearing only on the lower surface. We have considered *P. lanigera* var. *Petriei* Cheeseman for these collections, but the leaves are even larger than described there, and numerous. In the collection from Lake Habbema the peduncles are glabrescent, sometimes having only a few scattered hairs.

Plantago stenophylla sp. nov.

§ OLIGANTHOS

Planta parva, acaulis; rhizomate valde verticali, crasso vel crassiusculo, radice primaria non visa (probabiliter demum nulla), radicellis robustis, elongatis (usque ad 8 cm. longis); foliis numerosis, rosulatis, sub-erectis vel adscendentibus, anguste linearibus, 1.5–4 cm. longis, 0.7–2 mm. latis, integris vel remote et minute dentatis, margine \pm revolutis, apice obtusis, glabris, crassiusculis, supra costa impressa, subtus prominula, basi paullo dilatatis ibique lana longa flavescente instructis; inflorescentiis axillaribus, primum breviter (2 mm.), demum longe (2 cm.) pedunculatis, pedunculo glabro; spicis plerumque 1-floris; bracteis \pm 1 mm. longis, rotundatis, concavis, basi intus longiuscule pilosis; sepalis oblongo-lanceolatis, 2–2.5 mm. longis, obtusis, obtuse carinatis, glabris; corollae tubo 2 mm. longo, lobis lanceolatis, 1.2 mm. longis; staminibus 4, antheris non visis; capsulis ellipsoideis, 8–10-spermis, circiter medio circumscissis; seminibus fuscis, 3–4-angulatis.

NETHERLANDS NEW GUINEA: Lake Habbema, *Brass* 9456 (TYPE), Aug. 1938, alt. 3225 m., alpine grassland (common bog herb); 7 km. northeast of Wilhelmina-top, *Brass & Meyer-Drees* 9920, Sept. 1938, alt. 3720 m., abundant in alpine bog turf.

NORTHEAST NEW GUINEA: Mt. Sarawaket, *Clemens*, s.n. May 1939, alt. about 3300 m., forming sod around pond margins with *Potentilla*, *Gentiana* and *Carex* (flower wine-purple, minute).

Plantago depauperata sp. nov.

§ OLIGANTHOS

Planta pulvinata; rosulis parvis, 1–3 cm. diametro, multifoliatis, aggregatis; foliis crassiusculis, 6–15 mm. longis, 1–1.5 mm. latis, linearibus, apicem versus angustatis obtusiusculis, basi sensim dilatatis ibique lana longa fulva involutis, ceterum glabris, integris, margine angustissimo translucetibus, supra punctulatis, costa supra paullo impressis; spica ad florem unicum reducta; pedunculo 5 mm. longo; floribus perfectis; bracteis 2, \pm flore vaginatim circumdantibus, basi intus pilis longis tenuibus bracteis fere aequantibus instructis, ceterum glabris, triangulari-ovatis, vix 4 mm. longis, sursum angustatis, apice obtusiusculis, obtuse carinatis, costa \pm brunnescente; sepalis ovato-lanceolatis, 3 mm. longis, acutis, glabris, teneris, obtuse carinatis; corollae tubo 2 mm. longo, lobis lanceolatis, 1.5 mm. longis, \pm reflexis; antheris longe exsertis; stigmatibus longe exserto; capsulae parte inferiore valde elongata, \pm 5 mm. longa, anguste obconica, parte superiore conica, \pm 2 mm. longa; seminibus 4–8, parvis, angulatis, subtiliter impresso-punctatis.

NETHERLANDS NEW GUINEA: Lake Habbema, *Brass* 9199 (TYPE), Aug. 1938, alt. 3225 m., plentiful in open boggy ground (gregarious, each plant forming a separate tuft \pm 1 cm. high; leaves blue-gray); 7 km. northeast of Wilhelmina-top, *Brass & Meyer-Drees* 9921, Sept. 1938, alt. 3800 m., gray-green rosettes forming the bulk of the sparse herbaceous cover on shallow soil of sandstone summits; northern slopes of Mount Wilhelmina, *Brass & Meyer-Drees* 10135, Sept. 1938, alt. 4150 m., often the chief plant on black sandstone heights.

Both this and the preceding species belong to section OLIGANTHOS Barneoud. In *P. depauperata* the capsule seems to answer the description of that of *P. barbata* var. *monanthos* (D'Urv.) Pilger; however, on comparison with scanty herbarium material from the Falkland Islands, we find the plants of the latter much coarser and of much more open habit than the New Guinean material. Whether the Falkland Islands material

is properly named we cannot say, but certainly the Archbold collections are not conspecific with it.

RUBIACEAE

Maschalodesme simplex Merr. & Perry, Jour. Arnold Arb. 25: 197. 1944.

BRITISH NEW GUINEA: Vailala River, Ihu, *Brass* 914, Feb. 9, 1926, rain forest (erect unbranched bush 5 feet high; leaves shining above; large acute stipules; inflorescence in supra-axillary clusters; fruit red, eight-angled).

At the time this species was described this specimen was unavailable for examination. Since the genus has not been reported in fruit before, it seems worth while to add a brief note. Two fruits are available, one of which has been opened. It contains 16 seeds, eight to a locule, biseriately arranged and imbricating upward. Dry fruit elliptic, 8-costate, 3–3.5 cm. long, 1.5–2 cm. diameter, minutely puberulous. Seed after being soaked irregularly subobtrigonus or subrhomboid, more or less angled, somewhat flattened and curved, hardly 1 cm. long, about 5 mm. wide at its greatest width, attached at the inner base and here somewhat pointed; radicle superior scarcely 3 mm. long, cotyledons ovate, about 2×1.5 mm., embryo straight; albumen thick, somewhat cartilaginous.

VALERIANACEAE

Triplostegia repens Hemsl. Kew Bull. 1899: 101. 1899; Diels, Bot. Jahrb. 62: 493. 1929; van Steenis, Bull. Jard. Bot. Buitenz. III. 13: 257. 1934.

NETHERLANDS NEW GUINEA: Lake Habbema, *Brass* 9208, Aug. 1938, alt. 3225 m., locally common on open boggy ground (flowers white).

NORTHEAST NEW GUINEA: Sarawaket, *Clemens* 6325, April 1937, alt. 1800–2400 m.; Morobe District, Upper Camp A, *Clemens* 10085bis, Mar. 1939; Ulap Trail, *Clemens* 41133, April 1940 (flowers white).

The two previous records of the New Guinean species of *Triplostegia* were based on fragmentary material. Hemsley described the plant as having repent stems, but the radical leaves were not seen. Diels indicated that, although in the plant from Sarawaket the stem was upright and much shorter than in the original which he had examined, he was of the opinion that it belonged to the same species. In the light of the material cited above we believe it is clear that the habit of the plant is closely adapted to its environmental conditions. If the roots are fairly close to the surface of the substratum, the basal part of the shoot is very short, and a pseudo-rosette of leaves develops at the surface. On the other hand, if the roots are deeply buried in the substratum the basal part of the shoot is longer depending on the distance it has to travel before reaching light and developing leaves. Possibly if the plant is in the shade longer internodes develop, the longest in the specimens at hand is 1.5 cm., but mostly they are very short (2–5 mm.); above the cluster of leaves the stem becomes scape-like with a pair of reduced leaves half way between the substratum and the inflorescence. There is considerable variation in the number of glands on the inflorescence, perhaps depending on the stage of development. The genus is known only from the Himalayas, Yunnan and New Guinea. We have reported similar ranges for *Stellaria saxatilis*

Buch.-Ham. in Don, and *Potentilla* of the *P. leuconota* complex, but the last two are also found in intermediate localities.

CUCURBITACEAE

Neoalsomitra Hutchinson

In a brief article published in the *Annals of Botany*, n. ser. 6: 95-102. 1942, Dr. J. Hutchinson has clearly shown that *Macrozanonia* Cogniaux is only a synonym of *Alsomitra* Roemer, both having been established on the same type-species. He proposed the new genus *Neoalsomitra* Hutchinson to take care of the rest of the species later included in *Alsomitra* Roemer.

Neoalsomitra Schultzzei (Cogn.) Hutchinson in *Ann. Bot.* n. ser. 6: 98. 1942.

Alsomitra Schultzzei Cogniaux, *Pflanzenr.* 66(IV. 275. I): 12. 1916.

BRITISH NEW GUINEA: Lower Fly River, east bank opposite Sturt Island, *Brass* 8149, Oct. 1936, climbing in reed swamps (flowers yellow; fruit green, indehiscent).

This appears to be the first record of this species since it was originally described on a specimen collected on the Augusta River, Northeast New Guinea.

Neoalsomitra integrifoliola (Cogn.) Hutchinson in *Ann. Bot.* n. ser. 6: 99. 1942.

Gynostemma integrifoliola Cogn. in *DC. Monog. Phan.* 3: 916. 1881.

Alsomitra integrifoliola Hayata, *Jour. Coll. Sci. Tokyo* 30: 121. 1911, *Ik. Pl. Formosa* 1: t. 38, 39. 1911; *Cogn. Pflanzenr.* 66(IV. 275. I): 17. 1916.

BRITISH NEW GUINEA: Central Division: Laloki R., Rona, *Brass* 3606, Mar. 1933, alt. 450 m., edge of rain forest, common (slender spreading climber; upper surface of leaves dull, lower shining; flowers very pale yellow). Western Division: Lower Fly River, east bank opposite Sturt Island, *Brass* 8116, rain forest, common on trees bordering swamps (liane; branchlets glaucous; leaves somewhat fleshy; flowers green). Reported by Hutchinson from Formosa, the Philippines, and Fiji.

Melothria Linnaeus

Melothria scabridula sp. nov.

Monoica, scandens; caulibus gracilibus, sulcatis, nodis sparsim pubescentibus exceptis, glabris; foliorum petiolo 1.5-3 cm. longo, supra canaliculato et marginibus minute pubescentibus, ceterum glabro; lamina tenuiter chartacea, 3-5-partita, margine subinciso-dentata, dentibus apiculatis, supra in sicco fusco-olivacea, consperse albido-scabridula et venis minute pubescente, subtus paullo pallidiora, levi, glabra vel novella venis minute pubescente, lobo terminali lanceolato, apice longiuscule acuminato, 4-8.5 cm. longo, ad basin 0.5-1 cm., in medio 1-2.3 cm. lato, lobis lateralibus 2.5-3 cm. longis, 1.5-2 cm. latis, sinu basilari late triangulari (5 mm. longo, 15 mm. lato) vel laminarum basi fere truncata; cirrhis simplicibus, gracilibus minute pubescentibus; ♂ inflorescentibus racemosis vel subcorymbosis, paucifloris (2-5-floris), pedunculo 1-1.5 cm. longo, minute pubescente; pedicellis usque 5 mm. longis; calyce campanulato, 3 mm. longo, glabro, dentibus 1 mm. longis, triangulari-subulatis; corolla 6 mm. longa, extus granulati-puberula, lobis rotundatis; staminum filamentis 2.5 mm. longis, puberulis, apice curvatis; antheris ellipticis,

connectivo apice leviter producto; ♀ solitariis in eadem axilla cum masculis dispositis; pedunculo 1.5–4 cm. longo; ovario subgloboso; calyce et corolla maris; staminodiis consperse et breviter pilosulis; stylo 3 mm. longo, basi disco cupulari; stigmatibus 3, 1 mm. longis, apice expansis complanatis, bilobatis; fructibus \pm globosis, 1 cm. diametro; seminibus stramineis, obovoideis, circiter 4 mm. longis, 3 mm. latis, basi angustatis, \pm complanatis, immarginatis, scrobiculatis.

NETHERLANDS NEW GUINEA: 9 km. NE. of Lake Habbema, *Brass 10621* (TYPE), Oct. 1938, alt. 2800 m., mossy forest, climbing over a stump on forest path; Bele River, 18 km. NE. of Lake Habbema, *Brass 11046*, Nov. 1938, alt. 2200 m., small climber in forest clearings (flowers yellow; fruit red).

This species is easily recognized by the deeply cut leaves, and the scrobiculate seeds, a character obvious even in the dried fruit.

Melothria belensis sp. nov.

§ EUMELOTHRIA

Monoica scandens; caulibus gracilibus, sulcatis, scabridulis, breviter et sparsim pilosulis vel puberulis; foliorum petiolo 1 cm. longo, gracili, densiuscule adpresse pubescente; lamina tenuiter chartacea, 4–10 cm. longa, 3.5–5 cm. lata, integra, cordata vel subhastata, apice acuminata vel interdum acuta, margine denticulata (dentibus inter se 4–15 mm. remotis) in sicco supra olivacea, scaberrima, subtus paullo pallidiore, praecipue venis scabridula vel fere levi, sinu basilari latissimo concavo, 3–6 mm. profundo vel fere nullo; cirrhis filiformibus basin versus sparsim et breviter pilosulis; ♂ racemis simplicibus vel interdum ramosis, 7–23-floris, pedunculo communi 1.8–3 cm. longo, puberulo, pedicellis 7–9 mm. longis, pubescentibus, inter se 2–4 mm. distantibus; calyce campanulato, 4–5 mm. longo et lato, dentibus triangularibus, acutis, 1 mm. longis, basi paullo latioribus, \pm nervatis; corolla 5–6 mm. longa, utrinque minute pubescente vel puberula, 5-lobata, lobis late ovatis; staminum filamentis 3 mm. longis, antheris subquadratis, bilocularibus, 2 mm. longis, vix 2 mm. latis, loculis rectis, connectivo latiusculo, obtuso, \pm ciliato; ♀ floribus solitariis, pedunculatis, pedunculo usque 4 cm. longo, puberulo, filiformi; calyce et corolla quam mare paullo majoribus; staminodiis 3; ovario oblongo, 5 mm. longo, 2 mm. diametro, basi angustato, apice breviter rostrato; stylo 5 mm. longo, basi disco cupulari (non annulariformi); stigmatibus 3, 3 mm. longo, apice subtriangularibus; fructibus tantum immaturis visis.

NETHERLANDS NEW GUINEA: Bele River, 18 km. NE. of Lake Habbema, *Brass 11082* (TYPE), Nov. 1938, alt. 2200 m., common in open grassy second growth forest (flowers yellow).

Melothria idenburgensis sp. nov.

§ EUMELOTHRIA

Monoica, scandens; caulibus glabris vel novellis consperse puberulis, sulcatis, nodis \pm puberulis; foliorum petiolo 1–2.5 cm. longo, \pm puberulo; lamina submembranacea, ovata, sagittata vel subhastata, 5–11 cm. longa, 2–6 cm. lata, apice acuta vel leviter acuminata, lobis basilaribus obtusis, margine remote et minute denticulata, supra scabriuscula, subtus levi, utrinque costa et nervis sparsim et consperse pilosulis, sinu basilari 1–2 cm. profundo, plerumque late triangulari; cirrhis simplicibus glabris, tenuibus; ♂ floribus solitariis vel geminatis, 5–10 mm. pedicellatis; calyce campanulato, 2 mm. longo, lobis subulatis, 1 mm. longis; corolla fauce pilosula, lobis extus \pm puberulis, ovatis, acutis, 3 mm. longis; staminum filamentis brevibus; antheris subquadratis, loculis rectis, margine dorsali

minute ciliatis, connectivo latiusculo, apice brevissime producto; ♀ floribus solitariis vel interdum geminatis, pedunculo \pm 1 cm. longo; ovario fusiformi; fructu ovoideo, apice breviter acuminato, circiter 1.7 cm. longo, 1 cm. diametro, in sicco longitudinaliter et irregulariter rugoso; seminibus oblongis basi paullo angustatis, 5 mm. longis, incl. 1 mm. alato-appendiculatis, 2 mm. latis.

NETHERLANDS NEW GUINEA: Bernhard Camp, Idenburg River, *Brass* 14100 (TYPE), April 1939, alt. 50 m., rain forest, occasional in fringe vegetation along streams (flowers white; fruit unripe).

A species showing some similarity to the description of *M. Thwaitesii* Schweinf. (*M. zeylanica* C. B. Clarke) but fruits not angled-costate.

Melothria aff. *leucocarpa* (Bl.) Cogn. in DC. Monog. Phan. 3: 601. 1881; Cogn. Pflanzenr. 66(IV. 275. I): 101. 1916.

Bryonia leucocarpa Blume, Bijdr. 924. 1826.

BRITISH NEW GUINEA: Lower Fly River, east bank opposite Sturt Island, *Brass* 8104, Oct. 1936, in low second growths on riverbank (flowers greenish; fruit soft, red).

This collection looks very much like the scanty material we have at hand of *Melothria leucocarpa* (Bl.) Cogn., but the fruits are red, not white.

Trichosanthes Linnaeus

Trichosanthes Pulleana Cogniaux ex Harms, Bot. Jahrb. 60: 160. 1925, vel aff.

Trichosanthes papuana Pulle, Nova Guin. Bot. 8(2): 406. 1910, non F. M. Bailey (1900).

BRITISH NEW GUINEA: Central Division, Mafulu, *Brass* 5347, Oct. 1933, alt. 1250 m., climbing in low regrowth forest (numerous pendent large red fruits about 20 cm. long, 8 cm. diameter, yellow inside, seeds black).

The above cited collection (in fruit only) agrees with the original description of this species in the general shape of the leaf and the glands near the insertion of the petiole. The petiole is 4–12 cm. long, the upper surface of the leaf is scabrous; the fruit is somewhat oblong-obovoid with a smooth surface; the seeds are a little more than 1 cm. long, 5 mm. wide, flattened, slightly narrowed at one end and shallowly emarginate at the other.

Trichosanthes mafuluensis sp. nov.

Caules graciles angulato-sulcati, \pm puberuli demum glabrati; foliis membranaceis, supra parce puberulis et scabriusculis, subtus molliter puberulis, interdum hic illic glandulis parvis conspersis; petiolo 3–5 cm. longo, pubescente; lamina ovata, profunde cordata, 9–20 cm. longa, 6–14.5 cm. lata, apice breviter acuminata, margine \pm remote serrato-denticulata, sinu basali 2–5 cm. profundo, 1.5–2 cm. lato, truncato-obtusio, medio ob lobos basiles paullo angustato; cirrhii sulcatis \pm pubescentibus, 2–3-fidis; racemis ♂ 4–8 cm. pedunculatis, plurifloris (\pm 15), pubescentibus et \pm minute glandulosis; bracteis sub pedicellis lineari-lanceolatis, circiter 8 mm. longis, integris, pedicellis gracilibus sub anthesi erectis, ad articulationem \pm 5–7 mm. longis; calycis tubo anguste infundibulari \pm 2 cm. longo, puberulo, lobis 4 mm. longis, lanceolatis, integris, acutis; corollae lobis oblongis, 7–8 mm. longis, obtusiusculis, granulo-puberulis, ciliis fimbriatis; filamentis brevissimis, glabris; antherarum capitulo 3 mm. longo, faucem attingente non exserto; floribus ♀ non visis.

BRITISH NEW GUINEA: Central Division, Mafulu, *Brass 5257* (TYPE), Oct. 1933, alt. 1250 m., climbing in forest regrowth brush (corolla white).

Trichosanthes dieniensis sp. nov.

Caules gracillimi, novelli puberuli demum glabrati, angulato-sulcati; foliis membranaceis, supra scabriusculis, subtus glabris; petiolo 2–4.5 cm. longo, glabro; lamina ovata, cordata, 4.5–12 cm. longa, 2.5–8 cm. lata, apice breviter acuminata, margine inconspicue et remote glanduloso-denticulata, sinu basali 0.7–2 cm. profundo, 1.3–3 cm. lato, obtuso vel subrotundato; cirrhis gracilibus bifidis, glabris; racemis δ 3–5.5 cm. pedunculatis, elongatis (9 cm. longis) \pm 7-floris; bracteis sub pedicellis obovato-oblongis, 3–5-lobatis vel incis; pedicellis erectis, ad articulationem vix 3 mm. longis; calycis tubo anguste infundibulari, 4.5–7.5 cm. longo, glabro, lobis circiter 1 cm. longis, lineari-subulatis, basim versus 1–3-denticulatis; corollae lobis \pm 1 cm. longis, ramoso-fimbriatis, fimbriis circiter 2 cm. longis, utrinque puberulis, fauce \pm puberulo-pilosulo; filamentis brevibus gracilibus; antherarum capitulo 6 mm. longo, novello glabro, sub anthesi puberulo; floribus φ non visis.

BRITISH NEW GUINEA: Ononge Road, Dieni, *Brass 3898* (TYPE), April 1933, alt. 500 m., massed on a dead tree trunk (flowers white).

CAMPANULACEAE

Pratia Archboldiana sp. nov.

Planta in sicco habitu rosulata, acaulescens vel caulibus brevissimis (2–4 mm. longis); foliis approximatis petiolatis, petiolo 3–7 mm. longo, piloso vel glabrato, lamina ovato-rotundata vel subrotundata, 0.5–1.5 cm. longa lataque, membranacea vel chartacea, margine undulata vel minute denticulata, supra consperse pilosa, subtus glabra; floribus solitariis, axillariibus, pedunculatis, pedunculo 2–4 mm. longo, pilosulo; ovario piloso, circiter 3 mm. diametro; calycis lobis lineari-lanceolatis, 3 mm. longis, pilosulis; corollae tubo 2.5 mm. longo, lobis 3 mm. longis, lanceolato-linearibus; antheris in tubum connatis, anticis breviter aristulatis; baccis globosis, \pm 3 mm. diametro, calyce et interdum corolla marcescente coronatis; seminibus brunneis, nitidis, levibus, obovoideis, circiter 0.8 mm. longis.

BRITISH NEW GUINEA: Murray Pass, Wharton Range, *Brass 4943* (TYPE), Aug. 1933, alt. 2840 m., under a rock wall on grassy bank of a creek, very rare (flowers red).

This specimen consists of a half dozen small plants, the largest of which is between 3 and 4 cm. diameter. Most of them are in fruit with the withered corolla still adhering to the apex, one flower-bud was found, and in this we found the anthers united in an oblique ring around the style, which character gave us the clue to the family. The species may possibly be related to *P. irrigua* (R. Br.) Benth., a native of Tasmania.

Lobelia conferta sp. nov.

Planta prostrata, parva, carnosula, glabra; ramis brevibus; foliis alternis, integris, oblongo-lanceolatis, 4–5 mm. longis, 1–2 mm. latis, apice rotundatis vel obtusis, sessilibus, basi decurrentibus, confertis; floribus in axillis foliorum superiorum solitariis; pedicellis 3–5 mm. longis, ebracteolatis; hypanthio brevi, calycis lobis lineari-lanceolatis, 1–1.4 mm. longis,

acutiusculis; corollae tubo 2 mm. longo, lobis 2 superioribus vix 2 mm. longis, inferioribus 3 vix 2.5 mm. longis, lanceolatis; filamentis in parte inferioribus liberis, superiore connatis, glabris; antherarum tubo 1.4 mm. longo, antheris 2 inferioribus apice sparsim et minute barbatis et appendiculato minuto instructis; capsula non visa.

BRITISH NEW GUINEA: Mt. Albert Edward, southwest slope, *Brass* 4417 (TYPE), July 1933, alt. 3680 m., on wet grassland (prostrate plant, very rare; leaves smooth, shining; flowers very pale purple).

This species, if it is a *Lobelia*, belongs to section HEMIPOGON, but we are unable to suggest any near relationships. It may possibly belong to *Pratia*, but without fruit it is difficult to say.

GOODENIACEAE

Leschenaultia filiformis R. Br. Prodr. 581. 1810; F. v. Muell. Frägm. Phytogr. Austr. 6: 9. t. 48. 1868; F. M. Bailey, Queensl. Fl. 3: 892. 1900; Krause, Pflanzenr. 54(IV. 277): 108. 1912.

BRITISH NEW GUINEA: Tarara, Wassi Kussa River, *Brass* 8387, Dec. 1936, savannah forest (common herb on acid gray soil; flowers pale blue). Queensland and northern Australia.

INDEX TO GENERA AND FAMILIES CONTAINED IN PLANTAE PAPUANAE ARCHBOLDIANAE, I-XVIII, AND FOUR SMALL PAPERS WITH SOME NEW GUINEAN SPECIES

In each instance the number preceding the colon represents the volume number of the Journal of the Arnold Arboretum and the one following the colon is the page on which the name first appears.

- | | |
|---|-----------------------------------|
| Acacia, 23: 395 | Arytera, 21: 522 |
| Acaena, 21: 190 | Astronia, 24: 434 |
| Acmena, 23: 247 | Astronidium, 24: 435 |
| Acronychia, 22: 55 | |
| Adenanthera, 20: 329; 23: 396 | Badusa, 25: 187 |
| Agatea, 24: 208 | Balanophora, 23: 383; 29: 152 |
| Aglaia, 21: 316; 29: 158 | Balanophoraceae, 23: 383; 29: 152 |
| Airosperma, 26: 14 | Barclaya, 23: 390 |
| Aizoaceae, 23: 386 | Barringtonia, 21: 292 |
| Albizzia, 23: 394 | Barringtoniaceae, 21: 292 |
| Allophylus, 21: 511 | Bauhinia, 23: 399 |
| Alphitonia, 20: 338 | Begonia, 24: 41; 29: 160 |
| Alstonia, 24: 211 | Begoniaceae, 24: 41; 29: 160 |
| Alyxia, 24: 211; 29: 164 | Berrya, 20: 339 |
| Amaracarpus, 27: 221 | Bikkia, 25: 183 |
| Amaranthaceae, 23: 385 | Bleekeria, 24: 213 |
| Ampelocissus, 22: 375 | Borreria, 26: 34 |
| Anacardiaceae, 22: 529; 29: 158 | Buchanania, 22: 529 |
| Antirhea, 26: 233 | |
| Aphanamixis, 21: 314 | Callitrichaceae, 22: 258; 29: 158 |
| Apocynaceae, 21: 199; 24: 210; 29: 163 | Callitriche, 22: 258; 29: 158 |
| Aquifoliaceae, 20: 333; 22: 258; 30: 40 | Calogyne, 22: 388 |
| Archidendron, 23: 391 | Calycosia, 27: 217 |
| Argostemma, 26: 13 | Campanulaceae, 22: 383; 30: 59 |
| Aristolochia, 23: 383; 29: 152 | Camptosperma, 22: 533 |
| Aristolochiaceae, 23: 383; 29: 152 | Canavalia, 23: 406 |

- Canthium, 26: 230
 Cardamine, 24: 207
 Carruthersia, 24: 215
 Caryophyllaceae, 23: 386; 30: 39
 Cassia, 29: 155
 Cayratia, 22: 378
 Celastraceae, 20: 335; 22: 260
 Celtis, 22: 253
 Ceodes, 20: 327
 Cephaelis, 27: 218
 Cerastium, 23: 387
 Ceratophyllaceae, 23: 390
 Ceratophyllum, 23: 390
 Chenopodiaceae, 29: 154
 Chenopodium, 29: 154
 Chisocheton, 21: 311; 29: 157
 Cissus, 22: 376
 Cleistocalyx, 23: 233
 Clematis, 24: 34; 29: 154
 Clitandropsis, 24: 210; 29: 163
 Coelospermum, 26: 263
 Coffea, 26: 256
 Colona, 20: 343
 Colubrina, 22: 264
 Connaraceae, 23: 391
 Coprosma, 26: 258
 Coptosapelta, 25: 186
 Cornaceae, 21: 527
 Corynocarpaceae, 22: 541
 Corynocarpus, 22: 541
 Couthovia, 23: 410; 29: 163
 Crotalaria, 29: 155
 Cruciferae, 24: 207
 Crudia, 23: 399
 Crypteronia, 22: 270
 Crypteroniaceae, 22: 270
 Cucurbitaceae, 29: 167; 30: 56
 Cupaniopsis, 21: 515
 Cynoctonum, 29: 163
 Cynometra, 23: 397
 Dacrydium, 30: 39
 Dalbergia, 23: 401
 Datisceae, 23: 407
 Decaspermum, 23: 233
 Deeringia, 23: 385
 Dentella, 26: 1
 Derris, 23: 403
 Desmodium, 23: 401; 29: 156
 Dodonaea, 21: 525
 Dolicholobium, 25: 183
 Duabanga, 22: 269
 Dysoxylum, 21: 299; 22: 256; 29: 157
 Elaeagnaceae, 22: 267
 Elaeagnus, 22: 267
 Elaeodendron, 20: 336
 Eugenia, 23: 246
 Euroschinus, 29: 158
 Evodia, 22: 34
 Excavatia, 21: 199
 Fagraea, 23: 412
 Flindersia, 20: 330; 22: 58
 Freycinetia, 20: 140; 21: 163
 Galium, 26: 265
 Gardenia, 26: 202; 29: 166
 Geniostoma, 23: 408
 Gentianaceae, 30: 45
 Gironniera, 20: 325
 Glinus, 23: 386
 Glycine, 29: 156
 Gompholobium, 23: 400
 Goodeniaceae, 22: 387; 30: 60
 Guioa, 21: 512
 Gymnosporia, 20: 335
 Gynostemma, 29: 168
 Gyrinops, 22: 264
 Haloragaceae, 23: 407; 29: 161
 Haloragis, 23: 407; 29: 161
 Harpullia, 21: 525
 Hedyotis, 26: 1
 Hippocrateaceae, 20: 336
 Hollrungia, 24: 210; 29: 160; 30: 44
 Hybanthus, 24: 208
 Hydnophytum, 26: 14
 Ilex, 20: 333; 22: 258; 30: 40
 Ixora, 26: 256
 Jagera, 21: 522
 Kellera, 22: 267
 Keraudrenia, 30: 44
 Kingiodendron, 23: 399
 Kurrimia, 20: 335
 Lagerstroemia, 22: 268
 Lasianthus, 27: 219
 Lecythidaceae, 29: 161
 Leea, 22: 380
 Leguminosae, 20: 329; 23: 391; 29: 155
 Lepiderema, 21: 521
 Lepsianthes, 21: 512
 Leschenaultia, 30: 60
 Lobelia, 22: 385; 30: 59
 Loganiaceae, 23: 408; 29: 163
 Lucinaea, 25: 197
 Lysimachia, 29: 162
 Lythraceae, 22: 268
 Mangifera, 22: 532

- Maniltoa, 23: 397; 29: 155
Maschalodesme, 25: 197; 30: 55
Mastixia, 21: 527
Mastixiodendron, 23: 416; 25: 205; 26: 254
Medinilla, 21: 198; 24: 423
Melastomataceae, 21: 198; 24: 422
Meliaceae, 21: 296; 22: 256; 29: 157
Melicope, 22: 45
Meliosma, 20: 356; 22: 262
Melothria, 29: 167; 30: 56
Memecylon, 24: 438
Mezoneurum, 23: 399
Micrechites, 24: 214
Microcos, 20: 342
Millettia, 23: 401
Mischocarpus, 21: 523
Mischocodon, 21: 524
Mitracarpus, 26: 36
Mitrasacme, 23: 410
Mollugo, 23: 386
Montia, 23: 386
Morinda, 26: 263
Mucuna, 23: 404; 29: 156
Mussaenda, 25: 192
Mycetia, 25: 196
Myrmecodia, 26: 26
Myrtaceae, 23: 233
Myrtus, 23: 237

Nauclea, 25: 187
Nealsomitra, 30: 56
Neonauclea, 25: 187; 29: 164
Nertera, 26: 33
Neuburgia, 23: 415
Nyctaginaceae, 20: 327
Nymphaea, 23: 388
Nymphaeaceae, 23: 388
Nymphoides, 30: 45

Ochrosia, 24: 213
Ophiorrhiza, 26: 7
Ormosia, 23: 400

Pachystylus, 26: 229
Pandanaaceae, 20: 139; 21: 163
Pandanus, 20: 160; 21: 169
Papuzilla, 24: 207
Parasponia, 20: 324; 22: 254
Parastemon, 21: 197; 22: 256
Parkia, 23: 396
Parsonsia, 24: 215; 29: 164
Passiflora, 30: 44
Passifloraceae, 24: 210; 29: 160; 30: 44
Pentaphragma, 22: 384
Perrottetia, 20: 336; 22: 261
Phaleria, 22: 265

Phyllocharis, 22: 387
Piptadenia, 23: 396
Pithecellobium, 23: 393
Pittosporaceae, 21: 175
Pittosporum, 21: 175
Planchonia, 21: 295; 29: 161
Plantaginaceae, 30: 52
Plantago, 30: 52
Polygonaceae, 23: 384; 29: 154
Polygonum, 23: 384; 29: 154
Portulaca, 23: 386
Portulacaceae, 23: 386
Potentilla, 21: 184
Pratia, 30: 59
Primulaceae, 29: 162
Pseudocarapa, 21: 315
Psychotria, 27: 193
Pueraria, 29: 156
Pygeum, 21: 191

Randia, 25: 198; 29: 165
Ranunculaceae, 24: 34; 29: 154
Ranunculus, 24: 36; 29: 155
Rhamnaceae, 20: 337; 22: 263
Rhus, 22: 536; 29: 159
Rhynchosia, 29: 157
Rinorea, 24: 208
Rosaceae, 21: 179; 22: 256
Rotala, 22: 268
Rourea, 23: 391
Rubiaceae, 23: 416; 25: 183; 26: 1, 229; 27: 193; 29: 164; 30: 55
Rubus, 21: 179
Rumex, 23: 384
Rutaceae, 20: 330; 22: 32

Sabiaceae, 20: 356; 22: 262
Sagina, 23: 387; 30: 39
Salacia, 20: 336
Sapindaceae, 21: 511
Saprosma, 27: 220
Semecarpus, 22: 537
Serianthes, 23: 393
Solanaceae, 30: 45
Solanum, 30: 45
Sonneratia, 22: 269
Sonneratiaceae, 22: 269
Spondias, 22: 533
Staphyleaceae, 22: 543
Stellaria, 23: 386
Sterculia, 30: 40
Sterculiaceae, 30: 40
Strongylodon, 23: 403
Symbegonia, 24: 59
Syzygium, 23: 248

Tarrietia, 30: 40

- Taxaceae, 30: 39
Tephrosia, 23: 400
Terminthodia, 22: 53
Tetractomia, 22: 53
Tetrameles, 23: 407
Tetrastigma, 22: 375
Thymeleaceae, 22: 264
Tiliaceae, 20: 339
Timonius, 26: 235
Tribulus, 21: 511
Trichosanthes, 30: 58
Trichospermum, 20: 340
Triplostegia, 30: 55
Turpinia, 22: 543

Ulmaceae, 20: 324; 22: 253
Uncaria, 25: 189
Urophyllum, 26: 229

Valerianaceae, 30: 55
Vavaea, 21: 297
Velleia, 22: 387
Ventilago, 22: 263
Versteegia, 26: 258
Viola, 24: 209
Violaceae, 24: 208
Vitaceae, 22: 375

Wahlenbergia, 22: 383
Wikstroemia, 22: 266
Wrightia, 24: 215

Xanthomyrtus, 23: 240

Zanthoxylum, 20: 330; 22: 32
Zizypus, 20: 337
Zygophyllaceae, 21: 511

ARNOLD ARBORETUM,
HARVARD UNIVERSITY.

ORIGIN OF THE ANGIOSPERMS: NEED FOR A BROADENED OUTLOOK ¹

I. W. BAILEY

WE ARE HEARING more and more of late, in various fields of human endeavor, regarding the significance of a "New Look." Much is being spoken and written regarding the necessity for a "New Systematics" and for a "New Morphology." All of us will, I believe, readily admit the need for new methodologies and for new points of view in the development of botanical science. However, if real progress is to be made, it is essential to analyze trends of putative originality to determine whether they are soundly conceived and of productive potentialities. This is particularly true in dealing with such complex and difficult problems as to how, when, and where the angiosperms originated, how they became so highly diversified and so widely distributed, and how they should be classified in a system of truly natural relationships.

The "New Morphology" commonly involves the basic assumption—to quote a recent exponent ²—that a comparison of the organs of angiosperms and of lower plants only makes sense if the former are abandoned as a starting point and if we allow ourselves to be guided only by paleobotanical evidence in the direction of evolutionary development. Is the sweeping generalization that we should be guided in the study of angiospermic phylogeny and classification solely by paleobotanical evidence a sound one? When shorn of its psilophytal halo, the "New Morphology" frequently consists in practice of highly speculative attempts to homologize specific parts—even teratological ones—of a few selected angiosperms with those of ancient land plants. In so doing, scant attention is given to long stretches of geological time during which profound morphological changes are likely to have occurred. Furthermore, the fact that many salient trends of morphological specialization are adequately preserved in the huge assemblage of surviving angiosperms is overlooked or ignored. This procedure of the "New Morphology" is not new, since it is essentially similar to that utilized in the past, for example, in interpreting the Magnoliaceae in terms of the Bennettitales and the Amentiferae in homology with the Gnetales.

It is not my intention to belittle the great contributions that the study of the Psilophytales and of other ancient land plants have made to a clearer understanding of the stem and of its appendages, but rather to

¹ Invitation paper read before the Paleobotanical Section of the Botanical Society of America, Sept. 13, 1948.

² LAM, H. J. Classification and the New Morphology. *Acta Biotheoretica* 8: 109. 1948.

emphasize the necessity for much broadened outlooks in discussion of the origin and the relationships of the angiosperms. We need "new looks," but they should be comprehensive, rather than narrow and excessively speculative ones. There are as grave dangers in indiscriminately interpreting selected structures of living angiosperms solely in terms of ancient Land Plants as there formerly were in studying fossil plants with excessive dependence upon the classical concept of the stem and leaf.

For example, recent attempts to establish the Sarcopodaceae as a new family of gymnosperms, and to utilize it as support of a stachyosporous line of angiosperms provide cogent evidence of inherent dangers in the methodologies of the "New Morphology." The authors³ of the new family have been forced to admit that *Sarcopus aberrans* is a species of the santalaceous genus *Exocarpus* and to change the name of the family to Exocarpaceae. If the Exocarpaceae are to be removed from the Santalaceae and placed in closer relationship to the gymnosperms such a transfer should be based, not solely upon superficial examinations of the flower of a single species, but upon comprehensive cytological, embryological, anatomical and general morphological studies of *Exocarpus* in comparison with other genera of the Santalaceae and of other families of the Olacales. In addition, phylogenetic conclusions should be in harmony with salient trends of morphological specialization in the angiosperms as a whole. In the case of *Exocarpus*, even an examination of the pollen and the xylem afford pertinent evidence in refutation of such premature phylogenetic generalizations. Similar objections apply in the use of selected parts of such genera as *Casuarina*, *Salix*, *Ricinus*, *Portulaca*, *Calothamnus*, etc. when divorced from their context in the dicotyledons as a whole.

It should be emphasized in these connections that diversified investigations of surviving angiosperms provide the only available means at present of morphologically characterizing this great group of the vascular plants, and for recognizing and of accurately identifying ancestral forms when found. Each botanical discipline, Taxonomy, Paleobotany, Phytogeography, Cytology, Embryology, Anatomy, Developmental Morphology, Genetics, etc., has important contributions to make in the ultimate solution of various aspects of the great central mysteries, but the limitations of each field of research in the solution of specific problems of phylogeny and relationship should be clearly visualized and freely admitted.

The Land Plants from the Psilophytales onward are aptly designated by some the Tracheophyta, since they are characterized throughout by the formation of tracheary tissue. The constituent cells of this tissue obviously perform two fundamentally important functions, 1) the conduction of water and solutes from the absorbing to the transpiring parts of the plant, and 2) the provision of mechanical strength in parts where they occur. The former function is facilitated by peculiarities in the

³ GAGNEPAIN, F. & ED. BOUREAU. Une nouvelle famille de Gymnospermes: les Sarcopodacées. Bull. Soc. Bot. France. 93: 313-320. 1946.

——— & ———. Nouvelles considérations systématiques à propos du *Sarcopus aberrans* Gagnepain. Bull. Soc. Bot. France. 94: 182-185. 1947.

form of the cells and by the loss of their cytoplasmic contents at maturity, the latter function by the remarkable physical structure and the chemical composition of their cell walls. The major trends of phylogenetic modification of the tracheary tissue of the Land Plants are associated with changes of equilibrium between these two fundamentally important physiological functions. In the case of most dicotyledons, there is a striking division of labor within the vascular tissues, certain linear series of tracheids becoming modified to form vessel members, whereas others assume an increasingly fiberlike form and may at times take on a storage function in addition to an exaggerated mechanical one. These salient trends of evolutionary specialization of the tracheary tissues are largely unidirectional and irreversible, and are fully and adequately preserved in surviving angiosperms. There fortunately are no serious missing links in these phylogenetic chains and it is not essential, for example, to search geological strata for vesselless pro-angiosperms since ancestral types of primitive xylem occur in living representatives of both the dicotyledons and the monocotyledons.

Before discussing the significance and the limitations of these phylogenies in the study of plant relationships, it is essential to comment briefly upon the character of the evidence upon which they are based. Large collections of materials of woody dicotyledons have gradually been accumulated at Yale, Oxford, Harvard and many other institutions. These collections when supplemented by herbarium specimens have afforded material for the study of many genera of *all* of the principal families of the angiosperms. In addition, sufficient developmental investigations have been made so that it now is possible to visualize salient trends of specialization of the xylem in terms of a phylogeny of successively modified ontogenies. In other words, the evolutionary picture has emerged, and has become increasingly distinct, as larger and larger volumes of data have been analyzed from the angiosperms and the gymnosperms as a whole. It has crystallized solely from the study of the vascular tissues themselves, and entirely independently of assumptions regarding the putative primitiveness of specific representatives of the dicotyledons or monocotyledons. Furthermore, these particular trends of evolutionary specialization cannot be read in a reverse direction, since no one is likely to argue, in the light of our present knowledge of the Tracheophyta, that tracheids originated from the dissociated members of vessels.

What then are some of the more important contributions that a knowledge of these unusually extensive and reliable vascular phylogenies can make in discussions of the origin and the relationships of the angiosperms? Obviously it would be possible to arrange the angiosperms according to a system of increasing specialization of the vascular tissues, but such a system of classification would prove to be as unsatisfactory as others that have been based primarily upon the study of restricted parts of plants. If a truly natural classification is to be attained, it must be based upon the analysis and the harmonization of evidence from *all* organs, tissues and parts. This is due to the fact that the morphological specializations of

different structures commonly are not synchronized. The flower or one of its parts may be changing rapidly at the time when the vascular tissues exhibit morphological stability or *vice versa*. In studying plant relationships, evidence from the vascular tissues is in general more significant in negations than in affirmative conclusions. This is due to the frequent occurrence of parallel trends of evolution in the various organs and tissues of the Land Plants. Thus, although it is impossible to derive truly primitive forms of xylem from highly specialized ones, close structural similarities may be due to parallel or convergent development rather than necessarily to close genetic relationship.

In illustration of these basic considerations, let us turn to a specific discussion of the present revival of assumptions regarding the possibility of deriving the angiosperms from the Coniferales, Gnetales, Bennettitales or Williamsoniales.

The Lycopsidea, Sphenopsida, and most of the Pteropsida are characterized by having essentially similar ontogenetic sequences in the development of their tracheary tissue. In a fully elongated axis, as seen in radial longitudinal sections, the earlier formed tracheary cells have loosely coiled helical thickenings, although they may be preceded at times by tracheids with annular thickenings. These cells are succeeded by tracheary cells having compactly coiled helical thickenings of very low pitch, and these in turn by elements exhibiting transitions between scalariformly reticulate and scalariformly bordered pitted walls. In certain groups of Land Plants, e.g., many Lycopsidea, Sphenopsida, and ferns, the subsequently formed tracheids have dominantly scalariform pitting, whereas in other groups, e.g., many seed ferns, Cordaitales and Cycadales, there are subsequent transitions between scalariform bordered pits and approximately circular ones of varying number and distributional patterns.

In the Ginkgoales, Coniferales, and Gnetales, this *normal* ontogenetic sequence, characteristic of a vast majority of the Land Plants, is profoundly modified. True scalariform bordered pitting is eliminated and circular bordered pits are formed in the earlier stages of the ontogenetic sequence, even in the first-formed tracheary cells with loosely coiled helical thickenings. This modification of the primary vascular tissues is firmly established in the Coniferales and Gnetales and is indicative of an ancient trend of drastic anatomical specialization. In the latter order, vessels developed from tracheids having circular bordered pits. On the contrary, in the stems of angiosperms, which have retained a primitive type of vesselless xylem, the ontogenetic sequence is of the normal type, and vessels have developed in both dicotyledons and monocotyledons, as in *Pteridium*, by the modification of tracheids with scalariform bordered pitting. Such fundamentally significant anatomical differences form an insuperable barrier to a derivation of the angiosperms from the Coniferales or the Gnetales. Thus, the presence of vessels in both the Gnetales and the angiosperms, which has so frequently been cited as evidence of relationship, actually negates such relationship. There are similarities between the end products of tracheary specialization in *Gnetum* and certain of the dicotyledons.

but they have arisen by entirely different developmental changes.

What then are the possibilities of deriving the angiosperms from the Bennettitales or Williamsoniales? Here the evidence from the vascular tissues alone is inconclusive. Although similar transitions between tracheids with scalariform and circular bordered pitting occur in the secondary xylem of vesselless dicotyledons and of certain cycadeoideas, the similarity is not indicative necessarily of close relationship, since it may be due to parallel evolutionary development. Furthermore, the possibility of deriving the angiosperms from the Bennettitales or Williamsoniales, as also from the Crystospermaceae or Caytoniales, appears to be negated by evidence from other parts of the plants, particularly the reproductive ones.

It is essential at this point to digress briefly for comment upon a recent attempt to derive certain ranalian families from the Bennettitales, and to arrange them in a linear evolutionary series.⁴ This effort is based largely upon the reported discovery of a new type of tracheary element in the Magnoliceae and supposedly related families, and affords a pertinent illustration of inherent dangers in a narrow anatomical look. The cells in question are of a well known tracheary type which was fully discussed at meetings of the Committee on Nomenclature of the International Association of Wood Anatomists. They are new only through changes in terminology.⁵ A broad anatomical look at the vascular plants as a whole reveals the fact that tracheids with a similar configuration of bordered pitting occur, not only in the Bennettitales but also in other gymnosperms, and in many orders of the dicotyledons as well as in certain families of the Ranales. Furthermore, the true significance of the configurations cannot be fully understood without reference to accumulated data regarding the physical structure of the walls of tracheary cells. It should be emphasized in passing that it is such sweeping generalizations, based upon limited and inadequate data, that have raised uncertainties and doubts in the minds of many botanists regarding the value and the reliability of anatomical evidence in the study of phylogeny.

Up to this point, I may have given the impression of an excessively pessimistic look at the problem of the origin of the angiosperms, in which the only certainties are negations and in which potential ancestors of the angiosperms are successively eliminated. However, if real progress is to be made in the solution of the great mystery, it is essential periodically to differentiate the *wheat* of reliable cumulative evidence from the *chaff* of excessive speculation. As a matter of fact, I am quite optimistic regarding advances that can be made in the near future, provided investigators in various botanical disciplines cooperate more actively in providing essential data for a well coordinated attack along a broad morphological front.

⁴ LEMESLE, ROBERT. Les divers types de fibres à ponctuations aréolées chez les dicotylédones apocarpiques les plus archaïques et leur rôle dans la phylogénie. Ann. Sci. Nat. Bot. et Biol. Végétale 7: 19-40. 1946.

⁵ BAILEY, I. W. The problem of differentiating and classifying tracheids, fiber-tracheids, and libriform wood fibers. Tropical Woods 45: 18-23. 1936.

Our knowledge of the vascular tissues of Land Plants has advanced to a position where it can aid materially in planning such a campaign, in avoiding serious pitfalls, and in restraining fruitless sorties in haphazard directions. Thus, the tracheary phylogenies, that are so clearly and fully preserved in surviving angiosperms, provide us with significant clues regarding the general habit of growth of ancestral dicotyledons. This is due to the fact that, in the various dicotyledonous families, herbs, vines, lianas, succulents, aquatics and extreme xerophytes exhibit a high degree of specialization of the vascular tissues, whereas vesselless xylem and the less modified forms of vessel-bearing xylem occur in large woody perennials, viz. shrubs or trees. Such facts negate the possibility not only of deriving structurally primitive types of arboreal dicotyledons from herbaceous ancestors, but also of deriving the monocotyledons from herbaceous dicotyledons, e.g., the Ranunculaceae. If the angiosperms are monophyletic, the monocotyledons and the dicotyledons must have diverged at an early date, since vessels have developed independently in the two groups.

Of the nearly 100 species of living dicotyledons, which have a primitive vesselless type of both primary and secondary xylem, all occur within the order Ranales, as broadly conceived by Engler and Prantl. Furthermore, an unusually complete record of the origin of vessels and of salient trends of specialization of the xylem is preserved within this order. That these occurrences are not purely fortuitous, and may have significant implications, is suggested by accumulating data regarding the pollen morphology of seed-bearing plants. Most of the families and orders of the dicotyledons are characterized by having tricolpate pollen or types of pollen that appear to have been derived phylogenetically from such grains. Tricolpate pollen is not known to occur in any other group of seed-bearing plants and therefore is indicative of a highly distinctive trend of specialization in pollen morphology. Monocolpate pollen, which is characteristic of so many seed ferns, Bennettitales, Cycadales and Ginkgoales, is of common occurrence in monocotyledons, but is largely confined in the dicotyledons to a number of the more woody families of the Ranales. In other words, insofar as I have been able to determine, the Ranales are the only order of the angiosperms in which both monocolpate and tricolpate pollen occur.

However, it was the remarkable carpels and stamens of a previously undescribed family of the Ranales, viz. the Degeneriaceae, which induced Dr. A. C. Smith and myself to initiate a series of comprehensive coordinated investigations of ranalian families, in which others are now actively cooperating. I have already reported, earlier in these meetings, upon the primitive, unsealed, conduplicate ranalian carpel and concerning its salient trends of specialization in different ranalian families. There are equally significant transitions in the Ranales between broad microsporophylls and stamens of a more conventional form. These investigations at least justify a "New Look" at the flower of the angiosperms as a whole. Comprehensive studies of the various orders and families of living angiosperms should eventually provide adequate accumulations of evidence

for determining whether the putative lines of stachyosporous dicotyledons actually are such or have been derived from a phyllosporous one such as characterizes the Ranales. It should be noted in this connection that detailed and extensive investigations of other parts of living angiosperms, viz. the leaf, fruit, seed, embryo-sac, seedling, etc. are essential in synthesizing a picture of a primitive angiosperm or angiosperms to serve as a guide to paleobotanists in their search for pro-angiosperms.

Allow me to conclude my remarks with a few brief comments upon those parts of the Earth's surface which appear to me to offer the most promising fields for future explorations. It is the living floras of northern Australia, New Guinea, New Caledonia, and Fiji and adjacent regions northward to southern China that have yielded and are continuing to yield the richest crop of missing links in the chains of angiospermic phylogenies. For example, of the nine known genera of primitive vesselless dicotyledons, five occur on New Caledonia and three are endemic on that island. Only a beginning has been made in the exploration of many of these floras and a continuous flow of significant new plants may be anticipated for some time to come as more and more complete collections are assembled. Furthermore, these living floras of southern latitudes have already yielded more structurally primitive dicotyledons than have all of the known fossil floras of northern latitudes. Therefore, I am inclined to question the assumption of a northern origin for the angiosperms at least until the Tertiary and Mesozoic rocks of these southern lands have been adequately explored. It should be emphasized, in addition, that comparatively little is known regarding the seed-ferns of the *Glossopteris* flora. Here again is a field in need of detailed exploration.

In conclusion, I may be permitted, as one who is approaching the terminal stages of his career, to offer a word of friendly advice to those of the younger generation of taxonomists, paleobotanists and morphologists who may become interested in the origin of the angiosperms: Look West young man toward the remnants of Gondwana Land!

INSTITUTE FOR RESEARCH IN GENERAL PLANT MORPHOLOGY,
HARVARD UNIVERSITY.

VALIDATING BOTANICAL NAMES BY REFERENCE TO PRE-1753 LITERATURE

D. CHATTERJEE

IN THE PAST, botanical names were considered validly published when they were accompanied by a reference to previously and effectively published literature. In many cases such literature was published before 1753. Furtado (*Gard. Bull. Str. Settlm.* 10: 170-71. 1939) has suggested that this method is wrong, and that such publication does not validate the names. This view appears to be contradictory to the existing practice and it seems necessary to discuss the subject with a view to clarifying this point.

Furtado's views summarised by himself are as follows (*l. c.*):—

"iv. No *Botanical Name* can be admitted as *valid* unless (1) it satisfies the conditions laid down as essential for the word or words constituting the name itself, and (2) it is accompanied by either (a) a valid description, or (b) a valid reference (*see* below v) . . .

"v. A REFERENCE is *valid* when it refers to a description published both in valid literature, and in accordance with the rules laid down as essential for the words constituting the description.

"vi. Consequently ALL REFERENCES TO INVALID LITERATURE, even when they include plates, should be *inadmissible* under the Rules.

"vii. SEVERAL NAMES (formerly ignored but recently resurrected and made the bases of many nomenclatural changes) whose sole claim for validity is that they were referred to a plate or description in invalid literature should be *invalid*: e.g.

"(1) In O. STICKMAN'S Dissertation on RUMPHIUS'S *Herbarium Amboinense* eds. 1754 and 1759, accepted as valid by Dr. E. D. MERRILL (*Interpr. RUMPH. Herb. Amboin.* 1917).

"(2) In BURMANN'S *Index* to RUMPHIUS'S *Herbarium Amboinense* eds. 1755 and 1769, accepted as valid by Dr. MERRILL (*cf. op. cit.*).

"(3) In ROXBURGH'S *Hortus Bengalensis* (1814), accepted as valid by the late Dr. C. B. ROBINSON (*Philipp. Journ. Sci.* VII, 1912, pp. 411-419) because ROXBURGH had referred under the names to plates in RUMPHIUS'S *Herb. Amb.*

"(4) In MOON'S *Catalogue of Indigenous and Exotic Plants of Ceylon* (1824) accepted as valid by Mr. A. H. G. ALSTON (*Ann. Roy. Bot. Gard. Peradeniya* XI, 1929 pp. 203-205) because they contain references to the plates or descriptions either in RHEEDE'S *Hortus Malabaricus* or in RUMPHIUS'S *Herbarium Amboinense*.

"(5) Several generic and specific names listed in nomenclators and *Index Kewensis* with references to invalid descriptions, whether or not published in valid publications."

It should be noted that Furtado has introduced a few unfamiliar terms in the above summary such as "valid and invalid literature," "invalid description," etc. By "invalid literature" Furtado means all botanical literature published before 1753. This is evident from his statement (*l. c.* 165), "*Epipogium* and *Pterocarpus* are said to have been validated

by a reference to pre-1753 literature; but Art. 20 invalidates this literature." It should be pointed out that Art. 20 reads as follows: "Legitimate botanical nomenclature begins for the different groups of plants at the following dates (a) *Phanerogramae* and *Pteridophyta*, 1753 (Linnaeus, *Species Plantarum* ed. 1)." This article essentially refers to botanical nomenclature and *not* to botanical literature. The suggestion to describe all botanical literature published before 1753 as "invalid" appears to be due to a misinterpretation of Art. 20. Botanical literature containing descriptions or plates of plants is effectively published when it is printed and distributed to botanical institutions. So far as the descriptions and plates are concerned they should be regarded as validly published irrespective of the year 1753. But the validity of binomial names used in these publications will be considered only from 1753.

Unless this interpretation is accepted we have to reject a large number of names from Linnaeus's *Species Plantarum*. For example, the name *Plumbago zeylanica* L., is published in *Species Plantarum* 151 (1753), with references to *Hortus Cliffortianus* 53 (1737), *Hortus Upsaliensis* 43 (1748), *Flora Zeylanica* 73 (1747), etc. The only description available in the *Species Plantarum* is "foliis petiolatis," which is an exact repetition of what is available in *Hortus Cliffortianus*. It is evident that the two words constituting the description are indeed insufficient and an adequate idea of the plant can only be obtained by reference to other effectively published descriptions in earlier literature. In a large measure, therefore, Linnaeus validated the name *Plumbago zeylanica* L. by reference to pre-1753 literature. Similar examples are also available from other names like *Jasminum officinale* L., *Justicia echioides* L., *Nyctanthes Sambac* L. and *Salvia pinnata* L. In the case of *Plumbago zeylanica* L., the repetition of the two words from *Hortus Cliffortianus* conveyed no additional information, as the reference itself was enough. What Linnaeus did, in this case, was to publish a binomial and validate it by reference to a previously and effectively published description in pre-1753 literature. This implication should be clearly understood.

In the above cases Linnaeus had actual specimens as well as previously published descriptions of these plants. There are, however, quite a number of cases where binomials were published and validated by Linnaeus solely on the basis of descriptions or plates in pre-1753 literature. Svenson's interesting paper on the descriptive method of Linnaeus (*Rhodora* 47: 278. 1945) shows that a large number of species described in his *Species Plantarum* were based on "Figures such as those of Plukenet and of Cornut's *Canadensium Plantarum Historia* 1635, and Sloane's *History of Jamaica*, of which Linnaeus had seen no herbarium specimens." A random examination of one hundred specific names from Linnaeus's *Species Plantarum* shows that about fifteen of these were based solely on such descriptions or plates in pre-1753 literature, and no herbarium specimens of these species are to be found in the Linnaean Herbarium. This very rough estimate may give some idea of the total number of species described by Linnaeus on this principle. The name *Cyclamen indicum* L. may serve

as an example in this connection. The name was validated in the *Species Plantarum* by a reference to *Flora Zeylanica* 401, 1747, which was based on two drawings by Hermann (Zeyl. 50-57). It is almost certain that Linnaeus did not see any specimen of this species and no specimen is available in the Linnaean Herbarium. It may be pointed out, in passing, that as a result, the correct identity of this plant is still very obscure.* Even if some of these names are still, and probably will always remain obscure, because they were based on such pre-1753 literature, that is no reason for rejecting this type of publication. The existing rules of nomenclature do not prevent others from following the practice initiated by Linnaeus. The first author on East Asiatic Botany who followed this principle and validated a binomial by reference to pre-1753 literature appears to have been Prain. He published the name *Sindora galedupa* Prain (Jour. As. Soc. Beng. 66: 483. 1897) by reference to Rumphius's *Herb. Amboinense* (2: 59, tab. 13. 1750). Furtado appears to have missed Prain's name in his list of Robinson, Merrill and Alston (*l. c.*).

From a consideration of these cases it will be understood that this practice of validating names by reference to pre-1753 literature is indeed an old one, starting in fact in 1753 with *Species Plantarum* itself. These names cannot be regarded as invalid, as argued by Furtado. The fallacy in Furtado's discussions lies in his assumption of all pre-1753 literature as "invalid literature." It appears to me that he has also failed to interpret correctly Articles 20, 36 and 37 of the rules of botanical nomenclature. Further, he has unfortunately confused the two phrases "effective publication" and "valid publication," and in all probability considered them as synonymous. It is admitted that "valid publication" of botanical names started from 1753, but the "effective publication" of botanical literature started much earlier, perhaps with the art of printing. A proper and logical interpretation of the rules would only lead us to accept these works (botanical literature) as effectively published. It is unfortunate that by misinterpreting the rules, Furtado has coined such terms as "invalid literature" and "invalid description."† In my opinion, this practice of validating new binomials by reference to pre-1753 literature is perfectly legitimate and in accordance with the existing rules. Such names are therefore to be regarded as valid names.

This subject was discussed at the Symposium of botanical nomenclature held at Utrecht (June, 1948) and there was general agreement to the view expressed by the writer in this paper.

* In *Pflanzenreich* — *Primulaceae* 4, 237: 248. 1905, Pax and Knuth wrongly considered *Cyclamen indicum* L. as a synonym of *Cyclamen persicum* Mill. Bailey, apparently following Pax and Knuth, has adopted *Cyclamen indicum* L. as the valid name of the commonly cultivated *Cyclamen* on grounds of priority (*Hortus Second* 227, 1941). From the original description of *Cyclamen indicum* L. it is evident that the plant is very different from *Cyclamen persicum* Mill., and the difference is so pronounced that *Cyclamen indicum* L. may ultimately prove not to be a *Cyclamen* at all.

† In *Gard. Bull. Str. Settlm.* 11: 1. 1939, Furtado has introduced such other unfamiliar terms as "priorable" and "impriorable" names, "typonymous formal homonyms" (*l. c.* 27), etc.!!

A few individual members also suggested that the practice referred to above, although perfectly legitimate, should be discouraged in future. There are two grounds for abandoning this practice, viz. (i) our present conception of a species has greatly changed from that of Linnaeus and other earlier authors. By supplying a binomial and referring to a description in pre-1753 literature, we indirectly admit that our conception of the species is the same as that of these early authors; (ii) the main object of publication is to clarify and amplify existing knowledge. The description of a plant should present a clearer idea of the species than could be had by reference to some of these early works. Furthermore, these works are becoming very rare; hence many herbariums do not have them. It is therefore desirable to give a description to validate new binomials. On these two considerations, I suggest the following recommendation to Art. 36:—

From 1950 onward, botanists are recommended to discontinue the practice of validating new binomials solely by reference to descriptions or plates in pre-1753 literature. This modification shall not affect binomials which are already published and validated by such reference.

ROYAL BOTANIC GARDENS,
KEW, ENGLAND.

NOTES ON SOME FIJIAN WEEDS AND
INTRODUCED PLANTS

WILLIAM GREENWOOD

A NUMBER of interesting weeds and introduced plants have been found in Fiji in regions other than the leeward coasts and so were mentioned only briefly in my previous articles on this general subject (Proc. Linn. Soc. 154: 92-106. 1943; Jour. Arnold Arb. 25: 397-405. 1944). In the present article notes on some of these plants are given. Some records of weeds common to both the dry and wet zones in Fiji are also given, but no attempt has been made to list all the weeds noticed or collected during various trips outside the dry zones. Some hitherto unpublished records for Fiji are also included. In most such cases the records are based upon specimens which are deposited in the herbarium of either the Royal Botanic Gardens, Kew, the Arnold Arboretum, or the Gray Herbarium.

In the articles mentioned above, published in 1943 and 1944, about 80 records new to Fiji were published; A. C. Smith has also listed new records of weeds and introduced plants in *Sargentia* 1: 1-148. 1942, and in *Bull. Torrey Bot. Club* 70: 533-549. 1943. From these records one might conclude that the number of weeds and introduced plants in Fiji is increasing rapidly, but I do not believe this to be the case. Many of the new records of recent years are from southeastern Viti Levu in the coastal portions of Serua, Namosi, Rewa, Naitasiri, and Tailevu Provinces, especially near the towns of Navua, Nasinu, and Nausori. Although the plants discussed may have been established for years, these districts have not previously been visited by anyone sufficiently interested in the weeds to collect and identify them and to publish the records.

In this paper families are discussed in the order of Bentham & Hooker's *Genera Plantarum*. Collection numbers found in the text italicized and in parentheses refer to the writer's specimens; these numbers are inserted only when the species has not previously been reported from Fiji. Some of the plants discussed were identified by members of the staff of the Royal Botanic Gardens, Kew, to whom I am grateful. Dr. E. D. Merrill and Dr. A. C. Smith, of the Arnold Arboretum, have identified most of the new records and have assisted me in the preparation of this article.

PORTULACACEAE

Talinum paniculatum (Jacq.) Gaertn.

In *Bull. Torrey Bot. Club* 70: 537. 1943, Smith states that this species has been recorded, in Fiji, only from the island of Ovalau. During 30 years' collecting in Fiji I have never seen it except in this one locality, near Levuka. Why this weed should have failed to spread, after its introduction into Fiji at least 80 years ago, and why it should have persisted around Levuka are interesting questions.

MALVACEAE

Sida acuta Burm. f.

This species has increased rapidly in recent years in Mba and Ra Provinces, Viti Levu, especially in open hilly country and sometimes to the exclusion of everything else. What would appear to be the earliest collection of this plant in Fiji is *Greenwood 99*, collected at Lautoka, Viti Levu, and identified and deposited at the Royal Botanic Gardens, Kew.

LEGUMINOSAE

Albizzia Lebbeck (L.) Benth.

Vanua Mbalavu; collected by Mrs. J. D. Tothill.

Acacia sp.

Near Varoko, Mba Province, Viti Levu (1182). This is apparently a recent arrival in the Colony and, as far as I know, occurs only at this one locality, where efforts are being made to eradicate it before it spreads. It grows to 12 feet high and is armed with strong spines.

Desmanthus virgatus (L.) Willd.

Lautoka, Mba Province, Viti Levu, near sea-level.

Cassia Leschenaultiana DC.

Near Tawarau, road from Lautoka to Rarawai, Mba Province, Viti Levu (1183); also near Lautoka, alt. about 180 m. (1183A). This species attains a height of 5 feet and appears to prefer well-drained, sloping ground.

Desmodium triflorum (L.) DC.

Near Nasinu, Naitasiri Province, Viti Levu. Also seen in several places in Tailevu Province but not collected there.

Alysicarpus vaginalis (L.) DC.

Near Nasinu, Naitasiri Province, Viti Levu.

Lourea vespertilionis (L.f.) Desv.

Mango and Lakemba Islands. The only previous Fijian record (*Greenwood* in *Proc. Linn. Soc.* 154: 96. 1943) is from Penang, Ra Province, Viti Levu. The specimens from Mango and Lakemba were collected by Mrs. J. D. Tothill and identified at Kew.

ROSACEAE

Chrysobalanus Icaco L.

Fairly plentiful in parts of Naitasiri Province, Viti Levu, especially between Nasinu and Nausori; also just above high-water mark in sand, Naitonitoni Beach, Serua Province, Viti Levu. This is one of the plants which A. de Candolle considered as probably being spread by ocean currents (*Hemsley, Bot. Voy. Challenger 1* (4): 279. 1885).

CRASSULACEAE

Bryophyllum pinnatum (Lam.) Kurz.

On flat top of large rock near creek, alt. about 1800 ft., western slopes of Mt. Evans Range, Mba [formerly Lautoka] Province, Viti Levu; no specimen collected.

MYRTACEAE

Psidium littorale Raddi.

Near sea-level on flat land between the Navua River and the Serua hills, Serua Province, Viti Levu. Since first recording this species, in Jour. Arnold Arb. 25: 397. 1944, I have heard that it was originally planted in the mentioned locality. However, it was quite naturalized when collected there in 1943.

TURNERACEAE

Turnera ulmifolia L.

Mango Island: *R. J. Lever*. Mr. Lever, Government Entomologist, collected this material in 1945; he informed me that he had also seen this species at Levuka, Ovalau. The only other published Fijian record is from Thakaundrove on Vanua Levu (*Sargentia* 1: 64. 1942).

CUCURBITACEAE

Momordica Charantia L.

Waste places, Navua, Serua Province, Viti Levu.

Coccinea cordifolia (L.) Cogn.

First recorded from Fiji in Jour. Arnold Arb. 25: 400. 1944, from the Lautoka district. Although it has not yet been noticed elsewhere, this species is starting to spread in the vicinity of Lautoka, Mba Province, Viti Levu. It prefers open sunny places, where it covers shrubs and small trees. It may become a pest in the cane-fields by smothering the cane or causing it to fall, as do *Quamoclit coccinea* (L.) Moench and *Q. pennata* (Desr.) Boj.

CACTACEAE

Opuntia vulgaris Mill.

Seashore near Tavua, Mba Province, Viti Levu. Recorded by Mr. B. E. V. Parham in Agric. Jour. Fiji 18: 56. 1947, where it is stated that all existing stands have been eradicated.

RUBIACEAE

Borreria laevis (Lam.) Griseb.

In damp open grassland at Nandarivatu, Mba [formerly Tholo North] Province, Viti Levu, alt. about 2700 ft.; also at Nasinu, Naitasiri Province, Viti Levu.

COMPOSITAE

Synedrella nodiflora (L.) Gaertn.

Navua, Serua Province, and also near Nasinu, Naitasiri Province, Viti Levu.

Cosmos caudatus H. B. K.

Near Nasinu, Naitasiri Province, Viti Levu.

Tithonia diversifolia (Hemsl.) A. Gray

Waste places, Navua, Serua Province, Viti Levu.

Erigeron pusillus Nutt.

In coral sand in depressions just behind the coast near Saweni, near Lautoka, Mba Province, Viti Levu; on open steep grassy western slopes of Mt. Evans Range, alt. about 2500 ft., Mba [formerly Lautoka] Province, Viti Levu.

Erigeron floribundus (H. B. K.) Sch.-Bip.

In Proc. Linn. Soc. 154: 99. 1943, I recorded this plant as growing up to 1000 ft. elevation. Actually it occurs up to 2700 ft. and is very common at about 2000 ft. on ground used by the Fijians for crops in the Lautoka section of Mba Province, Viti Levu.

Elephantopus mollis H. B. K.

Nandarivatu, Mba [formerly Tholo North] Province, Viti Levu, alt. about 3000 ft. In open sunny places and also in thick forest wherever a clearing occurs or the track is wide enough to admit a certain amount of sunlight.

Distreptus spicatus (Aubl.) Cass.

Sandy soils near coast, Lautoka, Mba Province, Viti Levu (1132).

Spilanthes acmella (L.) Murr.

Along roadside on lower slopes, Serua hills, Serua Province, Viti Levu; waste land near Nausori, Tailevu Province, Viti Levu. The only previous record for Fiji (Sargentia 1: 141. 1942) is from Thakaundrove Province, Vanua Levu.

Taraxacum officinale Weber.

Open grassland, Nandarivatu, Mba [formerly Tholo North] Province, Viti Levu (1172).

Struchium sparganophorum (L.) Kuntze.

In low-lying wet places near Nasinu, alt. about 100 ft., Naitasiri Province, Viti Levu (1107).

LOBELIACEAE

Isotoma longiflora (L.) Presl.

Damp places in Rewa, Tailevu, and Naitasiri Provinces, Viti Levu; also at Nandarivatu, alt. about 2700 ft., Mba [formerly Tholo North] Province, Viti Levu.

Lobelia zeylanica L.

Damp shady places, near road hills between Navua and Suva in Namosi Province, Viti Levu; shady places, Serua hills, Serua Province, Viti Levu; in wet places, sometimes in standing water, near Nasinu, Naitasiri Province, Viti Levu. When not in flower, this plant somewhat resembles *Cardamine sarmentosa* Forst., which also grows in water and other very wet places and is gathered and eaten as a water-cress in Fiji.

APOCYNACEAE

Allamanda cathartica L.

Open sunny places near Nasinu, alt. about 100 ft., Naitasiri Province,

Viti Levu (1195). This commonly cultivated garden plant was found covering several acres near Nasinu, where there had evidently been a house at one time. It was covering the clearing and climbing over small trees near by, appearing quite naturalized.

CONVOLVULACEAE

Ipomoea obscura (L.) Ker.

In shady places near sea-level, Lautoka, Mba Province, Viti Levu (821). First noticed by me about 1935, this species thus far shows no tendency to spread or to become a bad weed.

Cuscuta australis R. Br.

The Director, Royal Botanic Gardens, Kew, informs me (in litt.) that the record of *C. densiflora* Hook. f. given by Miss Gibbs from Nandarivatu refers to this species.

SOLANACEAE

Browallia americana L.

Near Nasinu, Naitasiri Province, Viti Levu (1116). A garden escape, found semi-naturalized about European houses in several places in Naitasiri and Tailevu Provinces. It was also seen as a weed in gardens at Nandarivatu, alt. about 2700 ft., Mba [formerly Tholo North] Province, Viti Levu.

SCROPHULARIACEAE¹

Scoparia dulcis L.

Near Nasinu, Naitasiri Province, and near Nausori, Tailevu Province, Viti Levu.

Bonnaya veronicaefolia (Retz.) Spreng.

Nausori, in damp places, Tailevu Province, Viti Levu; collected by Mr. R. Veitch (330). I am indebted to the Director, Royal Botanic Gardens, Kew, for the identification of this plant, which was collected in May, 1921. I did not see it during a visit to Nausori a few years ago, and the record was overlooked when I prepared the previous weed articles.

Lindernia anagallis (Burm.f.) Pennell.

Near Nasinu, Naitasiri Province, Viti Levu, in wet places. The only other record for Fiji (Jour. Arnold Arb. 25: 397. 1944) is from Serua Province, Viti Levu.

Lindernia diffusa (L.) Wettst.

Covering wet banks at side of road, hills between Navua and Suva in Namosi Province, Viti Levu.

Lindernia microcalyx Pennell & Stehlé.

In wet places and sometimes in standing water, near Nasinu, Naitasiri Province, Viti Levu (1110).

¹ Dr. F. W. Pennell, of the Academy of Natural Sciences, Philadelphia, has kindly provided several of the identifications listed in this family.

Torenia polygonoides Benth.

Damp shady places near Nasinu, Naitasiri Province, Viti Levu (1099).

Mazus japonicus (Thunb.) Kuntze.

Damp shady banks near Nausori, Tailevu Province, Viti Levu (1105).

Angelonia angustifolia Benth.

Damp open sunny places between Mulamula and Yavuna, alt. about 500 ft., Mba [formerly Nandi] Province, Viti Levu; open hillsides between Lautoka and Mt. Evans, alt. about 1800 ft., Mba [formerly Lautoka] Province, Viti Levu (25). This plant is commonly grown in gardens in Fiji by Europeans, Fijians, and Indians. *Greenwood 25* was collected in 1920 and identified at Kew, but I did not see the plant again in this locality and therefore did not include it in my articles on the weeds and adventive flora of the leeward coasts. However, in June, 1947, I observed the species flowering well and apparently naturalized at two places several miles apart inland from Nandi, and therefore it should doubtless be recorded here.

ACANTHACEAE

Asystasia gangetica (L.) T. Anders.

Near Nasinu, Naitasiri Province, Viti Levu. First noticed in Fiji at Levuka, Ovalau, in 1927.

Thunbergia alata Boj.

Near Thuvu, Nandronga & Navosa Province, Viti Levu. Commonly called Black-eyed Susan, this creeper has a corolla of which the throat is sometimes black and sometimes not.

Blechum pyramidatum (Lam.) Urb. [*B. Brownei* (Sw.) Juss.]

Near Nasinu, Naitasiri Province, Viti Levu.

LABIATAE

Hyptis pectinata (L.) Poit.

Open places on hills, road from Navua to Suva in Namosi Province, Viti Levu. During a trip around Viti Levu by car this species was not noticed in Serua Province, but it occurs from the cited locality in Namosi Province through Rewa, Naitasiri, and Tailevu Provinces where the road passes. During such a trip in 1945 the northernmost plants along the road were seen about two miles south of the turn-off to Ellington Wharf, Ra Province.

Salvia coccinea Juss. ex Murr.

Listed by Gibbs (in Jour. Linn. Soc. Bot. 39: 161. 1909) from the Nandrau Valley, alt. about 1000 ft., Nandronga & Navosa [formerly Tholo North] Province, Viti Levu. The species does not otherwise appear to have been recorded from Fiji.

PLANTAGINACEAE

Plantago major L.

Nandarivatu, alt. about 2700 ft., Mba [formerly Tholo North] Province, Viti Levu. Seemann, in *Flora Vitiensis*, notes this species as common,

but during the past 30 years I have seen it only at Nandarivatu and Suva. It has not been noticed on the leeward coasts of Viti Levu or Vanua Levu.

AMARANTHACEAE

Iresine Herbstii Hook.

This is another species listed by Gibbs (in Jour. Linn. Soc. Bot. 39: 161. 1909) from the general vicinity of Nandarivatu, Viti Levu, which appears not to have been collected — or at least not recorded — since her report.

CHENOPODIACEAE

Chenopodium ambrosioides L.

Nandi, Mba [formerly Nandi] Province, Viti Levu. Mr. B. E. V. Parham has published an interesting note on this species in Agric. Jour. Fiji 17: 24. 1946. Here the plant is noted as a new record for Fiji, but it was earlier listed by Horne (A Year in Fiji, 259. 1881) without discussion. At present it appears to be confined to the Nandi district.

PIPERACEAE

Peperomia pellucida (L.) H. B. K.

In shady places near Nasinu, Naitasiri Province, Viti Levu.

EUPHORBIACEAE

Phyllanthus urinaria L.

Near Navua, Serua Province, Nasinu, Naitasiri Province, and Nausori, Tailevu Province, Viti Levu. Formerly recorded from Nandarivatu, in Sargentia I: 46. 1942.

Phyllanthus Niruri L.

Near Navua, Serua Province, Viti Levu.

Euphorbia Peplus L.

Nandarivatu, alt. about 2700 ft., Mba [formerly Tholo North] Province, Viti Levu (1171). A weed in gardens and on cultivated ground.

URTICACEAE

Pilea microphylla (L.) Liebm.

Along roadside in shade, hills between Navua and Suva, Namosi Province, Viti Levu; Nandarivatu, alt. about 2700 ft., Mba [formerly Tholo North] Province, Viti Levu; Lautoka, near sea-level, Mba Province, Viti Levu.

SALICACEAE

Salix sp.

On bank of sand and stones at edge of river a few miles below Tumbenasolo, Mba [formerly Nandi] Province, Viti Levu (1191). The family has apparently not previously been recorded from Fiji.

IRIDACEAE

Sisyrinchium micranthum Cav.

F. M. Bailey (Weeds and suspected poisonous plants of Queensland,

192. 1907) states that this species is believed to be poisonous and that it causes violent scouring in stock. The plant is very small and, when not in flower, is difficult to discern among grasses. It is recorded thus far in Fiji only from the vicinity of Nandarivatu (in Bull. Torrey Bot. Club 70: 535. 1943), but it may be expected to spread over some coastal pastures by means of flood waters.

AMARYLLIDACEAE

Agave sisalina Perr.

Open hillsides at about 500 ft., near Thuvu, Nandronga & Navosa Province, Viti Levu.

PONTEDERIACEAE

Monochoria hastata (L.) Solms.

Mr. B. E. V. Parham records this plant (as *M. hastaefolia*) for the first time from Fiji, in Agric. Jour. Fiji 18: 39. 1947. He states that it occurs throughout the Navua district, in all parts of the lower Rewa, and in rice fields between Samabula and Suva Point. It was pointed out to me by Mr. Parham at Nanduruloulou and I also saw it near Nasinu (both in Naitasiri Province, Viti Levu), but specimens were not collected.

CYPERACEAE

Cyperus Iria L.

Lautoka, Mba [formerly Lautoka] Province (806), and Wangandra, Mba [formerly Nandi] Province (806A), Viti Levu. This species was first noticed by me at Wangandra in 1932 and near Lautoka in 1940. It is a bad weed in rice fields in the Lautoka and Nandi districts, springing up and dying down during the wet season. It has been seen at about 1000 ft. elevation on hills near Lautoka.

Cyperus difformis L.

In standing water near Nasinu, Naitasiri Province, Viti Levu.

Cyperus compressus L.

The annual form of this, mentioned in Proc. Linn. Soc. 154: 105. 1943, appears to be confined in Fiji to the vicinity of Lautoka, in my observation. A perennial form, up to 10 or 12 inches high, is found in Mba [Lautoka], Nandronga & Navosa, Naitasiri, and Tailevu Provinces, Viti Levu, usually in damp or wet grassland.

Cyperus alternifolius subsp. *flabelliformis* (Rottb.) Kükenth.

Banks of Navua River near Navua, Serua Province, Viti Levu.

Cyperus Haspan L.

Common in drains and other wet places in Naitasiri and Tailevu Provinces, Viti Levu.

Cyperus distans L. f.

Near Nausori, Tailevu Province, Viti Levu.

Scirpus Purshianus Fernald [*S. debilis* Pursh, non Lam.]

In standing water in drains near Navua, Serua Province, Viti Levu

(980). During a month's visit at Navua this species was observed at only one place and was not plentiful there.

Eleocharis geniculata (L.) R. & S.

In coral sand in depressions just behind the coast near Saweni, near Lautoka, Mba Province, Viti Levu.

Fimbristylis miliacea (L.) Vahl.

In standing water in drains, near Nasinu, Naitasiri Province, Viti Levu.

GRAMINEAE²

Ischaemum aristatum L. [*I. ciliare* Retz.].

Near Nasinu, Naitasiri Province, Viti Levu.

Ischaemum timorense Kunth.

The record of this species in Fiji, noted in Bull. Torrey Bot. Club 70: 534. 1943, was based on *Greenwood 817*, collected in 1939 from roadside on the Navua flats between Navua and Suva in Serua [not Rewa as previously stated] Province, Viti Levu. In May, 1943, the species was collected all along these flats, on the banks of the Navua River (Serua Province), and also on the hills along the road from Navua to Suva in Namosi Province.

Ischaemum rugosum var. *distachyum* (Cav.) Merr.

In soak area near creek in open, western slopes of Mt. Evans Range, Mba [formerly Lautoka] Province, Viti Levu (1038B).

Sorghum halepense (L.) Pers.

Lambasa district, Mathuata Province, Vanua Levu. This record should have been included in my earlier articles but it was overlooked. The species has been present near Lambasa for over 30 years.

Themeda quadrivalvis (L.) Kuntze.

Roadside between Lautoka and Rarawai, Mba Province; hills at about 1200 ft. alt., between Lautoka and Mt. Evans Range, Mba [formerly Lautoka] Province, Viti Levu.

Brachiaria subquadrifaria (Trin.) Hitchc.

Damp places near sea-level, Lautoka, Mba Province (93A), and near Nausori, Tailevu Province (93B), Viti Levu. This species has been combined by some botanists with *B. distachya* Stapf; I am indebted to Mrs. Chase for pointing out the differences. She writes: "It is related to *B. distachya* Stapf but has more numerous racemes and slightly longer spikelets. It is more frequent in the islands than is *B. distachya*, to which it has commonly been referred." Much of the material listed by Summerhayes & Hubbard (Kew Bull. 1927: 32; 1930: 256) under *B. distachya* will prove to represent *B. subquadrifaria*. Apparently *B. distachya* prefers damper places than *B. subquadrifaria* and has a more compact growth of a lighter green color.

² For some of the listed identifications of grasses I am indebted to Mrs. Agnes Chase and Mr. J. R. Swallen, of the U. S. National Herbarium.

Brachiaria erucaeformis (J. E. Sm.) Griseb.

On banks of sand and stones along creek in open, alt. about 200 ft., Lautoka, Mba Province, Viti Levu (1081, depauperate). Previously known, in the Pacific, from only the Philippines and Guam, according to Mrs. Chase.

Axonopus compressus (Sw.) Beauv.

Fairly common near Navua, Serua Province, near Nasinu, Naitasiri Province, and near Nausori, Tailevu Province, Viti Levu.

Echinochloa stagnina (Retz.) Beauv.

In drains, near Nausori, Tailevu Province, Viti Levu. The only previous record from Fiji (Jour. Arnold Arb. 25: 397. 1944) was from drains near Navua, Serua Province, Viti Levu.

Cyrtococcum oxyphyllum (Hochst. ex Steud.) Stapf.

In open places in forest along road between Navua and Suva, Namosi Province, and in shady places near Nasinu, Naitasiri Province, Viti Levu.

Setaria barbata Kunth.

Levuka, Ovalau, in shady places. Although the species was apparently quite common at Levuka when I was there in 1932, it has been previously recorded, in Fiji, only from Koro (Kew Bull. 1930: 260).

Setaria geniculata (Lam.) Beauv.

On open flat rock at extreme western end of Mt. Evans Range, alt. about 3400 ft., Mba Province, Viti Levu (962, 962A). The only previous record of this species in Fiji (in Sargentia 1: 6. 1942) is based on *Degener & Ordenez 13514*, which I believe to represent *S. pallidifusca* (Schumacher) Stapf & Hubbard, a tall annual grass; *S. geniculata* is perennial.

Setaria pallidifusca (Schumacher) Stapf & Hubbard.

Near sea-level near Navua, Serua Province, Viti Levu.

Isachne dispar Trin.

In wet ground in open beside creek, alt. about 2700 ft., Nandarivatu, Mba [formerly Tholo North] Province, Viti Levu (1178).

Eragrostis pilosa (L.) Beauv.

Navai, near Nandarivatu, alt. about 2500 ft., Mba [formerly Tholo North] Province, Viti Levu.

Arundo Donax L.

Along road, hills between Navua and Suva, Namosi Province, Viti Levu; along creek, lower western slopes of Mt. Evans Range, alt. about 1800 ft., Mba [formerly Lautoka] Province, Viti Levu.

COLONIAL SUGAR REFINING CO.,

LAUTOKA, VITI LEVU, FIJI.

STUDIES IN THE BORAGINACEAE, XVII

IVAN M. JOHNSTON

A. CORDIA SECTION VARRONIA IN MEXICO AND
CENTRAL AMERICA

WHILE PREPARING AN ACCOUNT of the Boraginaceae for the southern West Indies it became necessary to typify the *Cordias* proposed by Linnaeus and also to re-examine the definition of certain widely ranging species. The results of these investigations came to involve a goodly proportion of the *Varronias* growing in Mexico and Central America. Since a discussion of them would be out of place in a paper dealing with the Antillean flora, they have been brought together and, with other observations, presented as a preliminary synopsis of the group for the region mentioned. Some of the species, e.g., *Cordia oaxacana*, *C. Pringlei*, *C. coyucana*, *C. curassavica*, and *C. spinescens*, have been treated cursorily and conservatively. They need much further study.

A few words are needed regarding the history, definition, and typification of *Varronia*. The name was coined and first used by Browne, Hist. Jam. 172 (1756), in describing Jamaican plants later called *C. globosa* and *C. curassavica*. Linnaeus was the first to use it in a strictly binomial classification, Syst. ed. 10, 916 (1759). He referred two species to it, *Varronia lineata* L. and *V. bullata* L. These two, both treated in the present paper, obviously belong to *Varronia* as usually defined. The group is, however, only a well-marked section of *Cordia*. It is confined to America and is best distinguished by fruiting structures. The fruit is usually matured in a cup-shaped calyx and is drupaceous. When ripe it has a conspicuous, thin, fleshy, usually cherry-red mesocarp which shrinks and fades and seems to disappear when the fruit is dried. The bony endocarp at maturity is usually single-seeded, irregularly ellipsoidal, and generally coarsely and irregularly tuberculate. The corolla in most *Varronias* has lobes much broader than long. The inflorescence is an open cyme in some species, but in most is either a dense head or a spike that matures its terminal flower first. In habit the plants are shrubs, woody scrambling climbers, or small trees. Many of them produce tiny aromatic granules on the herbage that give them a characteristic sagy odor. *Cordia parvifolia* DC. (*C. Greggii* Torr.; *C. Watsonii* Rose), although placed in *Varronia* by some authors, is accordingly here excluded. Among Mexican species *C. parvifolia* is actually most closely related to *C. elaeagnoides* DC. Note should be made of the treatment of *Varronia* by Friesen, Bull. Soc. Bot. Genève sér. 2, 24: 115–201 (1933). That author not only treats *Varronia* as a genus, but has even broken it up into a number of segregate

genera. Personally I am entirely unable to find any justification for treating the Mexican and Central American species under four distinct genera, *Varronia*, *Montjolya*, *Ulmarronia*, and *Cordiopsis*, as Friesen proposes.

KEY TO SPECIES

- Corolla large, 1–3 cm. long, pure white, salverform or funnelform.
- Calyx clothed with abundant spreading hairs; tip of lobes conspicuously prolonged, filiform, 2–5 mm. long.....1. *C. oaxacana*.
- Calyx clothed with straight appressed hairs, tip of lobes weakly or not at all prolonged (less than 2 mm. long).
- Corolla 2–3 cm. long, with a slender elongate tube much exerted from the calyx; leaves ovate to elliptic, 2–3 times as long as broad; calyx-lobes prolonged into free tips 1–2 mm. long.....2. *C. limicola*.
- Corolla 1–2 cm. long, its proper tube short and barely exerted from the calyx; leaves lanceolate, 3–5 times as long as broad; calyx-lobes with tips scarcely prolonged.....3. *C. podocephala*.
- Corolla much smaller.
- Foliage clothed with stellate hairs.
- Calyx-lobes with well-developed very elongate linear tips 2–5 mm. in length; heads in bud 2–3 cm. in diameter.....4. *C. Pringlei*.
- Calyx-lobes with inconspicuous or scarcely if at all developed free tips; heads in bud 10–18 mm. in diameter.....5. *C. stellata*.
- Foliage bearing simple hairs only.
- Flowers borne in a forking cyme.
- Leaves firm, usually broadest at or above middle, the upper surface distinctly scabrous from an abundance of short stiff appressed hairs; calyx-lobes abruptly short-acuminate, their apices free and forming a short but distinct tip on the unopened calyx.....6. *C. foliosa*.
- Leaves not very firm, usually broadest at or below middle, the upper surface bearing only widely scattered strongly appressed hairs; calyx-lobes acute; unopened calyx with unappendaged apex.....7. *C. bifurcata*.
- Flowers borne in heads or spikes.
- Flower-clusters capitate.
- Peduncles mostly axillary.....8. *C. lineata*.
- Peduncles never axillary, but terminal or internodal.
- Calyx-lobes with apex acute or with prolonged tips only 1 mm. long or less.
- Heads ellipsoidal, somewhat longer than broad, 10–15 mm. thick; mature fruit enclosed by a loose papery accrescent calyx and eventually freed by the break-up of the latter.....9. *C. coyucana*.
- Heads globose, not longer than broad, mostly 10 mm. or less thick.
- Calyx at anthesis 4–6 mm. long, glabrous or with only scattered relatively coarse appressed hairs; calyx-lobes distinctly attenuate, the tips 0.5–1 mm. long, free and usually spreading in the bud; corolla flaring, about 5 mm. long; leaves lance-ovate, ovate, or elliptic, 2–6 cm. broad, upper surface with branches of veins usually evident.....10. *C. ambigua*.
- Calyx at anthesis 1.5–3 mm. long, clothed with abundant minute usually appressed hairs, lobes deltoid, the acute apices not free in the bud; corolla tubular, 2.5–4 mm. long; leaves usually lanceolate or ob-

lanceolate and 1-2 cm. broad but occasionally becoming lance-ovate to elliptic and up to 5 cm. broad, upper surface with branches of veins rarely if at all evident.....11. *C. inermis*.

Calyx-lobes with prolonged free linear tips 2-4 mm. long.

Leaves firm, thickish, with sharp teeth and a sharply acute apex, lower surface with a prominent reticulum of repeatedly branched and anastomosing veins, and with one or more small, well-defined concave or obconic depressions in many of the vein-areoles; upper leaf-surface usually verrucose, with short stiff ascending or nearly erect hairs arising from bulbous bases; peduncles usually elongating, usually over 2 cm. long; corolla 4-6 mm. long, usually hardly surpassing the calyx, the tube expanding into a subcampanulate throat...12. *C. bullata*.

Leaves thinner, usually with rounded teeth and obtusish at the tip, lower surface with simple veins or these sparsely and inconspicuously branched and anastomosing, rarely developing any small concave depressions; upper leaf-surface more or less strigose, the hairs arising from unthickened or from flat or merely convex pustulate bases; peduncles usually less than 2 cm. long; corolla 5-9 mm. long, usually surpassing the calyx, funnelliform, the tube expanded into a broadly obconic throat.....

.....13. *C. globosa*.

Flower-clusters elongating, spikes.

Base of petiole not decurrent on the subtended axillary shoot, at most only the basal 1-2 mm. hardening and persisting on defoliated branches; plant an erect shrub bearing no axillary inflorescences; spikes borne singly, either terminal or springing from naked internodes along leafy stems.....14. *C. curassavica*.

Base of petiole decurrent for 5-10 mm. on the subtended axillary shoot or peduncle, usually persisting as a conspicuous indurate decurved spur on defoliated branches; plant a scrambling shrub, producing most of its spikes (singly or in panicles) from the axils along leafy stems, only those first produced by the stem being terminal.

Calyx-lobes with short free tips forming a short but distinct apical prolongation on the unopened calyx; spikes borne in terminal and axillary panicles.....15. *C. costaricensis*.

Calyx-lobes without free tips, the unopened calyx with a rounded unappendaged apex; spikes rarely paniculate, most of them springing singly from the leaf-axils along the stems..

.....16. *C. spinescens*.

1. *Cordia oaxacana* DC. Prodr. 9: 497 (1845).—near Tololapa, Oaxaca, *Andrieux* 203.

Varronia oaxacana (DC.) Friesen, Bull. Soc. Bot. Genève sér. 2, 24: 175 (1933).

Cordia appendiculata Greenm. Field Mus. Pub. Bot. 2: 338 (1912).—Cañon de Tomellin, Oaxaca, *Conzatti* 2218.

Varronia oaxacana var. *appendiculata* (Greenm.) Friesen, Bull. Soc. Bot. Genève sér. 2, 24: 176, t. 1, f. 8 (1933).

Cordia perlonga Fernald, Proc. Am. Acad. 33: 90 (1897).—Acapulco, *Palmer* 70.

Cordia urticacea Standley, Contr. U. S. Nat. Herb. 23: 1222 (1924).—Real de Guadalupe, Guerrero, *Langlassé* 355.

Varronia urticacea (Standl.) Friesen, Bull. Soc. Bot. Genève sér. 2, 24: 174 (1933).

MEXICO: Aguas Calientes, 1837, *Hartweg* 181 (G); Zacuapan, Vera Cruz, *Purpus* 8477 (G, US); Lake Chapala, Jalisco, *Hitchcock & Stanford* 7174 (G, US); Zitacuaro to Coyota, Michoacan, tree 3 m., *Hinton* 13153 (G, US); Acapulco, Guerrero, 1895, *Palmer* 70 (G, TYPE of *C. perlonga*; US); San Antonio, Guerrero, shrub 1.5-2 m., *Hinton* 10256 (G, US) and 10542 (G, US); Real de Guadalupe, Guerrero, shrub 2 m., *Langlassé* 355 (US, TYPE); Picacho to San Geronimo, Oaxaca, *Purpus* 6692 (G, US); Rio de los Vuelos, Oaxaca, *Liebmann* 15158 (G); Cuesta de Quiotepec, Oaxaca, *Smith* 700 (G) and *Conzatti* 4027½ (G, US); Tomellin Canyon, Oaxaca, 3-4.5 m. tall, *Pringle* 4630 (G, US); between San Geronimo and La Venta, Oaxaca, *Nelson* 2785 (G, US); San Geronimo, Oaxaca, *Mell* 2133 (US); Ixtepec, Oaxaca, *Fisher* 35250 (US); Salina Cruz, Oaxaca, *Fisher* 35492 (US); Tehuantepec, Oaxaca, *Matuda* 244 (US).

The species is confined to southern Mexico and appears to be very variable. Specimens referred to it are rather diverse in appearance, but until more collections of it accumulate and more is learned of its behavior in the wild, I believe it had best be given the broad definition here accepted. From plant to plant the corolla may be moderate-sized or large and differ greatly in the length of corolla-tube protruded from the calyx. These differences, however, may possibly be associated with heterostyly. Leaf-form is variable, and so also is the type of hairs on twigs and foliage. The leaves are usually ovate or elliptic and rounded or obtuse at the base. The plant described as *C. perlonga*, however, has very elongate leaves that are acute or attenuate at the base and very scantily pubescent beneath. Its peduncles, also, are unusually elongate. The plant described as *C. urticacea* has the twigs and peduncles bristly with spreading brownish hairs. Hinton's two collections from Guerrero (nos. 10256 and 10542) show that it is not sharply distinct from other forms of the species.

2. *Cordia limicola* Brandeg. Univ. Cal. Pub. Bot. 6: 502 (1919).—Corral de Piedras, Vera Cruz, *Purpus* 8017.

Varronia limicola (Brandeg.) Friesen, Bull. Soc. Bot. Genève sér. 2, 24: 148 (1933).

Cordia passa Johnston, Jour. Arnold Arb. 29: 227 (1948).—Jacala, Hidalgo, *Chase* 7461.

MEXICO: near San Lucas, Jaumave, Tamaulipas, *Rozynski* 563 (G); Jacala, Hidalgo, *Chase* 7461 (G, TYPE of *C. passa*) and *Moore* 1823 (G); Corral de Piedras, Zacuapan, Vera Cruz, *Purpus* 8017 (G, US, ISOTYPE of *C. limicola*) and *Purpus* 7491 (G, US); Mirador, Vera Cruz, 1857, *Mohr* (US); Rio Talva, Aug. 1842, *Liebmann* 12718 (US).

A well-marked species known only from middle eastern Mexico. Its closest relatives are *C. podocephala* Torr. of northeastern Mexico and *C. mirabiloides* (Jacq.) R. & S. of Cuba and Haiti. Typical *C. passa* differs from typical *C. limicola* only in having smaller, more hairy leaves, and is obviously only an ecological form of the latter.

3. *Cordia podocephala* Torr. Bot. Report U. S. & Mex. Bound. Survey 135 (1859).

Varronia longifolia Sessé & Moc. Fl. Mex. 48 (1893), ed. 2, 44 (1894) -- Type from "Praedio de la Punta."

TEXAS: Eagle Pass, Maverick Co., *Havard* 10 (G); Montell Creek, Uvalde Co., *Cory* 14902 (G), 26 mi. north of Uvalde, *Cory* 49398 (G); George West, Live Oak Co., *Skinner* 898 (US); near Dinero, Live Oak Co., 1940, *Highway Dept.* (G); Bee Co., 1940, *Tharp* (G); San Patricio Co., 1941, *Tharp* (G); 11 mi. northwest of Falfurrias, Duval Co., *Cory* 14751 (G); "Blanco Canyon, rich bottom land," *Reverchon* 1562 (US).

MEXICO: 11 mi. south of Allende, Coahuila, weak shrub 1-1.5 m. tall, *Johnston* 7023 (G); Hacienda Mariposa, Coahuila, *Wynd & Mueller* 240 (G); Musquiz, Coahuila, *Marsh* 140 (G); Soledad, southwest of Monclova, Coahuila, 1880, *Palmer* 1024 (G); Cañon Bocatoche, Coahuila, *Muller* 3112 (G); Monterrey, Nuevo Leon, *Pringle* 1877 (G, US), 11639 (G, US), and *Mueller* 322 (G); Victoria, Tamaulipas, 1907, *Palmer* 453 (G, US); Cerro Tamaulipeca, Tamaulipas, *Bartlett* 10631 (G, US); Jaumave, Tamaulipas, *Viereck* 319 (US).

A very well marked species which is closely related only to *C. limicola*. It ranges just north of the latter species in Tamaulipas, Nuevo Leon, Coahuila, and in adjoining Texas.

4. *Cordia Pringlei* Robins. Proc. Am. Acad. 26: 169 (1891).—Las Palmas, San Luis Potosi, *Pringle* 3091.

Varronia Pringlei (Robins.) Friesen, Bull. Soc. Bot. Genève sér. 2, 24: 168 (1933).

Cordia Pringlei var. *altatensis* Brandeg. Zoe 5: 219 (1904).—Yerba Buena near Altata, Sinaloa, *Brandegee*.

Cordia asterothrix Killip, Jour. Wash. Acad. 17: 330 (1927).—Rio Limon, Venezuela, *Curran & Haman* 808.

Cordia Storkii Standley, Pub. Field Mus. Bot. 18: 984 (1938).—Catalina, Guanacaste, Costa Rica, *Stork* 2758.

The species ranges in the drier parts of Mexico, Central America and northern Colombia and Venezuela.

MEXICO: Victoria, Tamaulipas, 1933, *Fisher* (G); Las Palmas, San Luis Potosi, shrub 3-4.5 m. tall, *Pringle* 3091 (G, TYPE of *C. Pringlei*; US) and 4058 (US); 100 mi. north of Tamazunchale, San Luis Potosi, 1-1.5 m. tall, *Hitchcock & Stanford* 6898 (G, US); State of San Luis Potosi, *Seler* 596 (G); Buenavista, June 1841, *Liebmann* 12714 (US); Acaponetla, Vera Cruz, *Purpus* 8484 (G, US); Topolobampo, Sinaloa, 1897, *Palmer* 182 (US); Yerba Buena near Altata, Sinaloa, 1904, *Brandegee* (G, US, ISOTYPES var. *altatensis*); Mazatlan, Sinaloa, *Ortega* 5616 (US); Cerro Llano Redondo west of Caymanero, Sinaloa, 8-15 m. tall, *Gentry* 7091 (G) and 7091A (G); Buena Vista, Apatzingan, Michoacan, shrub 4 m., *Hinton* 12072 (G, US).

GUATEMALA: near Estanzuela, dept. Zacapa, 7-9 dm. tall, *Steyermark* 29102 (G); between Zacapa and Chiquimula, 2-3 m. tall, *Standley* 73784 (G) and 74448 (G); near Jutiapa, 2 m. tall, *Standley* 74969 (G).

NICARAGUA: Managua, *Garnier* 1084 (US); indefinite, *Wright* (G, US).

COSTA RICA: Bebedero, Guanacaste, *Brenes* 12546 (G, FM); Catalina, Guanacaste, 5 m. tall, *Stork* 2758 (FM, TYPE of *C. Storkii*); Puerto Jesus, Nicoya, 1903, *Cook & Doyle* 747 (US); Estero de Puerto Jesus, 1903, *Pittier* 16690 (US).

COLOMBIA: between Quebrada de Angeles and Rio Cabrera, dept. Huila, *Rusby & Pennell* 333 (G).

VENEZUELA: Rio Limon, *Curran & Haman* 808 (US, TYPE of *C. asterothrix*; G).

The species is most closely related to *C. stellata* of Mexico and to *C. macrocephala* (Desv.) HBK. of Peru and *C. polyantha* Benth. of Ecuador and northern Peru.

5. *Cordia stellata* Greenm. Proc. Am. Acad. 39: 86 (1903).—Cuicatlan, Oaxaca, *Smith* 147.

MEXICO: Cameron, Vera Cruz, *Purpus* 8715 (G, US); near San Luis Tlutiltanapa, Puebla, *Purpus* 3242 (G, US); Cuicatlan, Oaxaca, *Smith* 147 (G, TYPE) and *Gonzales* 983 (G); Cuesta de Quioatepec, dist. Cuicatlan, *Conzatti* 2461 (G); Cuesta de Coyula, dist. Cuicatlan, *Conzatti* 4136 (US); 6 mi. above Dominguillo, Oaxaca, *Nelson* 1646 (G, US); Cerros Teotitlan, Oaxaca, *Conzatti* 3456 (G); Rio Vuelto, Oaxaca, July 1842, *Liebmann* 12715 (US).

The plant is very closely related to *C. Pringlei*, but it is always dis-

tinguishable by its smaller heads and very short or inconspicuous tips on the calyx lobes.

6. *Cordia foliosa* Mart. & Gal. Bull. Acad. Brux. 112: 330 (1844).—Zacupan, Vera Cruz, *Galeotti* 7094.

Cordia chiapensis Fernald, Proc. Am. Acad. 40: 52 (1904).—Ocuilapa, Chiapas, *Nelson* 3003.

MEXICO: Corral de Piedras, Vera Cruz, *Purpus* 8062 (G); Zacupan, Vera Cruz, *Purpus* 10785 (G, US) and 10811 (G, US); La Palmilla, *Purpus* 16410 (G); Mirador, Vera Cruz, *Liebmann* 12703 (G, US); Hacienda de la Laguna, Vera Cruz, *Schiede* 146 (NY); Ocuilapa, Chiapas, *Nelson* 3003 (G, TYPE of *C. chiapensis*; US); Monserate, Chiapas, *Purpus* 14 (US).

GUATEMALA: Puebla viejo Quen Santo, Huehuetenango, *Seler* 3011 (G); north-west of Cuilco, Huehuetenango, *Steyermark* 50806 (G).

A very well marked species and the only *Varronia* with loose, distinctly forked cymes known from Mexico and northernmost Central America.

7. *Cordia bifurcata* R. & S. Syst. 4: 466 (1819).—Based on *V. dichotoma* R. & P.; not *Cordia dichotoma* Forst. (1786).

Varronia dichotoma R. & P. Fl. Peruv. 2: 23, t. 146 (1799).—Type from Chachahuasi, Peru.

Atlantic slopes of Costa Rica and Panama and from there south along the Andes of South America.

COSTA RICA: La Colombiana Farm, prov. Limon, 2–3 m. tall, *Standley* 36641 (US); near Carmen Station, prov. Limon, 15–30 dm. tall, *Standley & Valerio* 48379 (US); Pejivalle, prov. Cartago, 1.5 m. tall, *Standley & Valerio* 46904 (US); Rio Turrialba, prov. Cartago, *J. D. Smith* 6608 (G, US); Turrialba, *Cook & Doyle* 370 (US); Juan Viñas, prov. Cartago, *Cook & Doyle* 302 (US); Valle Tuis, basin of Rio Reventazon, prov. Cartago, *Tonduz* 11353 (G, US); Aguacaliente, prov. Cartago, *Stevens* 324 (US); Rio Hondo, plains of Santa Clara, *Cook & Doyle* 530 (S); San Jose, *Tonduz* 11353 (US); Villa Quesada, prov. Alajuela, *Austin Smith* 2542 (G); Las Vueltas, Tucurrique, *Tonduz* 12759 (US).

PANAMA: Almirante, Bocas del Toro, *Cooper* 83 (G); Changuinola Valley, Bocas del Toro, *Dunlap* 90 (G); western Panama, 1923, *Stork* 16 and 19 (US).

This is one of the previously unrecognized species that has been contained in the complex, passing under the names *C. ulmifolia*, *C. corymbosa*, and *C. polycephala*. It is the common representative of the complex in Colombia and southward along the Andes into northern Argentina, and is readily delimited except where it approaches the area of its Brazilian relatives in Paraguay and northeastern Argentina. Though formerly not distinguished from the other Central American member of the complex, *C. lineata*, it is decisively separable and utterly different in appearance. In *C. bifurcata* the cymes are all terminal or internodal, and usually very evidently so. Though at times the flower clusters may be rather dense, they always show some evidence of being two-lobed and in the very mature fruiting condition always reveal a forked rhachis to some extent. Usually, however, the cyme is evidently forked even in bud and is generally very conspicuously so when in fruiting state. This is all very different from the condition in *C. lineata*, where the small, distinctly capitate inflorescences spring from axils along the leafy twigs. The foliage of the two species also differs. In our present plant the leaves usually

have a thinner texture than in *C. lineata* and are conspicuously very much less hairy, especially on the upper surface.

8. *Cordia lineata* (L.) R. & S. Syst. 4: 464 (1819).

Varronia lineata L. Syst. ed. 10, 916 (1759); Amoen. Acad. 5: 394 (1759); Sp. Pl. ed. 2, 275 (1762); Syst. ed. 12, 176 (1767).—Jamaica.

Cordia ulmifolia var. *lineata* (L.) DC. Prodr. 9: 495 (1845).

Lantana corymbosa L. Sp. Pl. 628 (1753); not *Varronia corymbosa* Desv. (1809), nor *Cordia corymbosa* Willd. (1819), nor Don (1838).—Jamaica.

Ulmarronia corymbosa (L.) Friesen, Bull. Soc. Bot. Genève, sér. 2, 24: 143 (1933), as to name-bringing synonym only.

? ? *Cordia adnata* DC. Prodr. 9: 493 (1845).—Cuba.

Ranging from southern Mexico to Panama, in the northern West Indies (Jamaica, Cuba, and Haiti), and possibly also in northern South America.

MEXICO: Zacuapan, Vera Cruz, *Purpus* 6272 (G, US) and 10825 (US); Jicaltepec, Vera Cruz, March 1841, *Liebmann* 12704 (US); Rio Cascabel, Oaxaca, *Mell* 2303 (US).

BRITISH HONDURAS: San Agustin, El Cayo Dist., *Lundell* 6756 (G, US).

GUATEMALA: Quirigua, dept. Izabel, *Standley* 23698 (G, US).

COSTA RICA: El General, *Skutch* 3831 (G, US), 4314 (G, US), and 4769 (US).

PANAMA: San Blas Dist., *Cooper* 276 (G, US); Balboa, *Standley* 25474 (G, US), 26068 (US), and 29245 (G, US); Punta Paitilla, *Heriberto* 212 (G, US); between Pacora and Chepo, *Woodson, Allen & Seibert* 1671 (G); Rio Tapia, *Standley* 28153 (US).

JAMAICA: St. Margarets Bay, *Fredholm* 3271 (US); Oxford, near Troy, *Harris* 9434 (US); indefinite, *Macfadyen* (G).

CUBA: Herradura, Pinar del Rio, *Van Hermann* 858 (G, US); between Herradura and Paso Real, *Shafer* 11769 (US); Viñales, Pinar del Rio, *Killip* 13543 (US); Los Palacios, Pinar del Rio, *Shafer* 11652 (US); Pitajones, Santa Clara, *Shafer* 12276 (US); Sancti Spiritus, Santa Clara, *Shafer* 12111 (US); Cieneguita, Santa Clara, *Combs* 420 (G); vicinity of Soledad, Santa Clara, *Jack* 5483 and 6629 (G, US); Soledad, *Howard* 6619 (G); La Gloria, Camaguey, *Shafer* 119 (G, US); Saltadero, Oriente, *Wright* 423 (G); between Lebisa Bay and El Purio, Oriente, *Shafer* 3429 (US).

HAITI: St. Michel de l'Ayalaye, *Leonard* 7519 (G, US); St. Louis du Nord, *Leonard* 14289 (US); Terre Neuve, *Buch* 542 (US); Pilate, *Leonard* 9651 (US); Plaisance, *Leonard* 9173 (US); Gros Morne, l'Artibonite, *Leonard* 9852 (US); Massif du Nord, Port Margot, Bayeux, *Ekman* 2560 (US); north of Morne Jeffrard, southern peninsula, *Bartlett* 17559 (US).

DOMINICAN REPUBLIC: San Jose de las Matas, prov. Santiago, *Jimenez* 959 (US); banks of Rio Mao to La Ceiba, prov. Monte Cristi, *Valeur* 474 (US).

VENEZUELA: Perija, Zulia, *Tejera* 8 (US); between Guamitas and Rancho Grande, P. N. Aragua, *Williams* 10368 (US); La Paragua, Bolivar, *Killip* 37614 (G); Avila, savana del monte, *Vogl* 710 (G).

COLOMBIA: Boyaca, Rio Meta, Orocué, Los Llanos, *Cuatrecasas* 4401 (US).

A very well marked but previously unrecognized species here associated with a neglected specific name long ago proposed by Linnaeus. The plant is known only from Mexico, Central America, and the northern West Indies and is to be found in herbaria mistakenly identified as *C. ulmifolia*, *C. corymbosa*, or *C. polycephala*. These latter names have, at one time or another, been used to cover a complex of species distributed from Mexico and Cuba south to Argentina. A study has shown that the aggregate can be broken up into a number of well-defined species. In the West Indies, Mexico, Central America, and coastal northern South America three species

should be segregated from the complex, our present species being one of them. *Cordia polycephala* (Lam.) Johnston, *sensu str.*, is another. It ranges in the West Indies from Santo Domingo through Porto Rico, the Virgin Islands, the Lesser Antilles, and Trinidad into northern South America, where it occurs in the Guianas, Venezuela, and coastal northern Colombia. The third segregate is *C. bifurcata* R. & S., which ranges north along the cordillera into Colombia and has outlying stations on the Atlantic slopes of Panama and Costa Rica. These three species, *C. lineata*, *C. polycephala*, and *C. bifurcata* have distinct patterns of geographic distribution and are easily distinguished by differences in inflorescence.

Most of the species of the section *Varronia* have peduncles that are either terminal or internodal and never axillary. This normal condition prevails in *C. bifurcata*. In *C. lineata* and *C. polycephala s. str.*, however, while the first few inflorescences on a long shoot may be terminal or internodal, the very abundantly produced later ones are all axillary. Their peduncles arise directly from the leaf-axils along the leafy shoot and have their foot confluent with the indurated basal portion of the petiole of the subtending leaf. In *C. lineata* the peduncles are very slender, 2-3 cm. long, and terminated by a small dense capitate flower-cluster. Only exceptionally do they branch or bear a reduced leaf. They are never clustered. In *C. polycephala s. str.* the cymes are commonly glomerate and are only rarely markedly spherical in form. The peduncles are coarser than in *C. lineata* and frequently branched. They tend to be especially numerous and even paniculately arranged towards the ends of the shoot. The corolla of *C. polycephala s. str.* averages larger than that in *C. lineata* and is more abundantly glandular-hairy inside. The upper surface of its leaves is minutely tuberculate and only sparingly strigose. In *C. lineata* the distinctly lanceolate leaves are less variable in form, dry a darker color, and average more elongate than in *C. polycephala s. str.* Their upper surface is evidently more hairy, since in addition to a coarse strigosity it bears minute tuberculations, comparable to those already noted in *C. polycephala*, which are here prolonged upwards into minute appressed hairs.

In geographic distribution *C. lineata* and *C. polycephala* approach each other only in the Dominican Republic and in western northern South America. The latter species I have seen from only three general localities in the Dominican Republic (Paradis, Barahona, *Fuertes* 998; vicinity of Ciudad Trujillo, *Ekman* 12336, *Allard* 13226 & 15742; and San Pedro de Macoris, *Rose, Fitch & Russell* 4162), all near the southern coast of the country and apart from the known localities in northern and western parts of the republic where *C. lineata* has been collected. Judging from material examined, the two species remain distinct and readily separable in the West Indies. Only in Venezuela is there any difficulty in distinguishing them. In northern South America *C. polycephala* ranges as far west as Santa Marta, Colombia (*Smith* 2737) and is particularly common and well distributed in Venezuela. In the latter country, unlike its behavior in other parts of its range, however, it tends to lose its stability and is accompanied by a goodly number of variants, some of which are

separable from *C. lineata* only with difficulty. The proper interpretation of these forms must await a detailed study of the Venezuelan *Varronias*. The specimens from Colombia and Venezuela cited above can, accordingly, be now only tentatively identified with typical *C. lineata*.

The oldest name applied to the present plant is *Lantana corymbosa* L. Sp. Pl. 627 (1753). Linnaeus applied the name to Jamaican plants treated by Sloane, Hist. 2: 83, t. 194, f. 3, and Plukenet, Alm. t. 328, f. 5. Sloane's plant most suggests true *Cordia polycephala*, a plant not known from Jamaica, but in any case it is probably not the same as the plant illustrated by Plukenet. Plukenet's plant is clearly representative of *C. lineata* as here accepted. The name *Lantana corymbosa* L. cannot be transferred to *Cordia*, since the resulting combination is already preoccupied by *Cordia corymbosa* Don, 1838 (based upon *Varronia corymbosa* Desv., 1809, a renaming of *V. monosperma* Jacq.), as well as by *Cordia corymbosa* Willd. ex R. & S., 1819. The name "*Varronia corymbosa* L.," Desf. Tableau 71 (1804), possibly may have been based on *Lantana corymbosa* L., but it is published merely as a bare name in a list for a botanic garden and cannot be accepted as a nomenclatorial transfer since its association with *L. corymbosa* L. is merely conjecture.

The name *Varronia lineata* L. Syst. ed. 10, 916 (early 1759) is the second one applied to our present plant. It was published thus: "*lineata*. A. V. fol. lanceolatis linearis, spicis oblongis. *Lantana corymbosa*. Spec. pl. 628. Brown, jam. t. 13. f. 2." The concept is a confused one. The phrase "spicis oblongis" in the diagnosis best describes *Cordia curassavica*. Browne's plate represents *Cordia globosa*. The reference to *Lantana corymbosa* involves two other species, one of which is the species we now have under consideration.

In Nov. 1859, Linnaeus's student, Elmgren, Amoen. Acad. 5: 394, gave under the name *Varronia lineata* a very good detailed description of our present species. It was based on a specimen collected in Jamaica by Browne. The specimen is now catalogued in the Linnaean Herbarium as no. 255.1 and has been discussed by Smith, Rees Cyclop. 36: sub *V. lineata* (1817).

In Dec. 1859, another student of Linnaeus, Sandmark, Amoen. Acad. 5: 376, applied the name *V. lineata* to a plant figured in Browne's History of Jamaica. Sandmark, by his reference to the second species treated by Browne on page 172, associated the name with what is probably *Cordia curassavica*.

The application of the name *Varronia lineata*, previously confused, was finally clarified by Linnaeus in the second edition of his Species Plantarum, 275 (1762), where he treated it as follows: "*lineata*. 1. VARRONIA foliis lanceolatis lineatis, pedunculis lateralibus petiolo adnatis, spicis globosis. Amoen. acad. 5. p. 394.* *Lantana corymbosa*, foliis alternis, floribus corymbosis. Sp. pl. 628. Ulmi angustifoliae facie baccifera jamaicensis, foliis superne scabris, floribus flavis perpusillis, fructu botryoide monospermo. Pluk. alm. 393, t. 328, f. 5. Habitat in America." The diagnosis is a new one and applies perfectly to our present

plant. The asterisk calls attention to the full description given by Elmgren. Sloane's plant, cited when *Lantana corymbosa* was published, is excluded by both the diagnosis and description. The Plukenet plant is the Jamaican plant here treated and the one with which Linnaeus is almost exclusively concerned in the second edition of the *Species Plantarum*. In the twelfth edition of the *System*, p. 176 (1767), the species appears as follows: "*lineata*. 1. V. fol. lanceolatis lineatis, pedunc. lateralibus petiolo adnatis, spicis globosis." This is the same diagnosis as that which first appeared in the second edition of the *Species Plantarum*, five years earlier.

In disposing of the two Linnaean names, *Lantana corymbosa* and *Varronia lineata*, there are only two choices that can be justified logically. They can be discarded as *nomina confusa*, or they can be typified by the Jamaican plant illustrated by Plukenet. The names were applied by Linnaeus to an aggregate, but to no more confused an aggregate than many other names of that author which have been subsequently restricted and are now generally accepted. In five out of the six times which Linnaeus or his students used the names between 1753 and 1767, the Jamaican plant illustrated by Plukenet was included in the species treated. It was not only a recurring element in the Linnaean concept, but also the one which Linnaeus eventually emphasized and allowed to dominate in his concept. I have accepted Plukenet's plate as typifying both *Lantana corymbosa* and *Varronia lineata*. This seems logical and furthermore is of some practical moment, since it provides a name for a species otherwise without one.

9. *Cordia coyucana* Johnston, Jour. Arnold Arb. 29: 227 (1948). — Coyuca, Guerrero, Hinton 8156.

MEXICO: Coyuca, Guerrero, 3 m. tall, Hinton 8156 (G, TYPE).

GUATEMALA: Jalapa, shrub 2 m. tall, Standley 76595 (G).

HONDURAS: (dept. Morazán): Zamorano, Valerio 139 (G); El Pedregal, Valerio 896 (G); road to Tatumbula, Valerio 532 (G).

COSTA RICA: Hacienda Santa Maria, Guanacaste, Dodge & Thomas 6294 (G); La Cruz de Guanacaste, 1890, Pittier 2751 (G).

The species is known only from the collections cited above. Although the plant has a large, plump, ellipsoidal or capitate inflorescence which is rounded at the base and hence very different from the elongating, more slender and narrower, basally attenuate spikes of *C. curassavica*, I believe it is most closely related to the latter species. In foliage, in bristly twigs, and in form and indument of the inflated fruiting calyx it is especially suggestive of those forms of *C. curassavica* found in Guerrero which have been described as *C. imparilis* Macbr. It can be noted here, as an interesting coincidence, that among the Mexican *Varronias* three very different species have developed very bristly forms in the state of Guerrero, i.e., *C. oaxacana* (*C. urticacea*), *C. curassavica* (*C. imparilis*) and *C. coyucana*.

10. *Cordia ambigua* Schl. & Cham. Linnaea 5: 115 (1830). — Jalapa, Schiede 216.

MEXICO: Jalapa, Vera Cruz, Schiede 216 (G, photo of TYPE); Jalapa, Rose & Hay 6139 (US); Jalapa, shrub 3-6 m., Pringle 8193 (G, US) and 9407 (G, US); Izuatlanchillo, near Orizaba, Vera Cruz, Boureau 2625 bis (G); near Orizaba, Boureau

2625 (G, US); Orizaba, *Botteri* 169 (G) and 181 (G); Tenango, near Orizaba, *Botteri* 482 (US); Dos Puentos, Oaxaca, Aug. 1842, *Liebmann* 12733 (US); Mt. Orando, Chiapas, *Matuda* 771 (G).

A very well marked species known only from southeastern Mexico.

11. *Cordia inermis* (Mill.), comb. nov.

Lantana inerma Miller, Dict. (1768).

Cordia cana Mart. & Gal. Bull. Acad. Brux. 112: 331 (1844).—Pacific slope of Oaxaca, *Galeotti* 7140.

Cordia insularis Greenm. Proc. Am. Acad. 33: 482 (1898).—Maria Madre Island, *Nelson* 4296.

Ranging from northwestern Mexico south through Central America to Panama and the dry north coast of Colombia. In Mexico it is confined to the seasonally dry Pacific slope and is found as far north as Sinaloa.

MEXICO: Ymala, Sinaloa, 1891, *Palmer* 1419 (G, US); San Juan, Sinaloa, *Ortega* 4030 (US); Rosario, Sinaloa, *Rose* 1825 (G, US); San Ignacio, Sinaloa, *Montes & Salazar* 550 (US); Culican, Sinaloa, 1904, *Brandeggee* (G); Yervacito, Sinaloa, 1904, *Brandeggee* (US); Maria Madre Island, *Nelson* 4296 (G, TYPE; US), *Solis* 68, *Ferris* 5629 (US), *Howell* 10518 (G) and *Mason* 1779 (G, US); Zapotlan, Jalisco, 3 m. tall, *Pringle* 4389 (G); Sacoalco, Jalisco, *Jones* 363 (US); barranca near Guadalupe, Jalisco, 1886, *Palmer* 84 (G, US); La Palma, Jalisco, *Jones* 364 (US); Barranca de Tequila, Jalisco, 1.5–4.5 m. tall, *Pringle* 4436 (G, US); Zitacuaro to El Souse, Michoacan, tree 2 m. tall, *Hinton* 13248 (G, US); Acapulco, Guerrero, 1895, *Palmer* 2 (G, US); Acatitlan, Mexico, 1 m. tall, *Hinton* 4337 (G, US); Tenatoc, Mexico, 3.5 m. tall, *Hinton* 4213 (G); Salitre, Mexico, 1.5 m. tall, *Hinton* 6510 (G, US); Tehuantepec, Oaxaca, *Matuda* 584 (G, US); Jalisco, Chiapas, *Purpus* 9211 (G, US); Mt. Orando, Chiapas, *Matuda* 683 (US).

GUATEMALA: divide between Zacapa and Chiquimula, shrub 2–3 m. tall, *Standley* 73704 (G); Gualan, Zacapa, shrub 3 m., *Deam* 6319 (G, US) and 6377 (G, US); Cobán, *Johnson* 39 and 567 (US); Guatemala City, *Tejada* 24 and 147 (US).

SALVADOR: Santa Ana, shrub 1.5–2.5 m., *Standley* 19689 (G, US); La Union, shrub 9–12 dm. tall, *Standley* 20668 (G, US); La Union, *Standley* 20843 (US); Izalco, dept. Sonsonate, *Standley* 22182 (G, US); San Salvador, *Velasco* 8926 (US) and *Calderon* 1068 (US); dept. Ahuachapán, *Sisto Alberto Padillo* 84 and 377 (US).

HONDURAS: Isla de Disposicion, 1.5 m. tall, *Stork & Worth* 8864 (G); Bella Vista, dept. Choluteca, shrub 2–3 m., *Williams & Molina* 10873 (G); Yeguaré, Morazán, *Valerio* 314 (G); Zamorano, Morazán, *Valerio* 174 (G).

NICARAGUA: Granada, *Oersted* 12799 (US); near Granada, *Maxon, Harvey & Valentine* 7624 (G, US); Managua, *Garnier* 1093 (US) and *Chaves* 9 (US); Momotombo, 1.8–2.1 m. tall, *C. L. Smith* 123 (G, US); Pueblo Nuevo, dept. Esteli, *Williams & Molina* 10808 (G).

COSTA RICA: road to Nicoya, *Tonduz* 13789 (G, US); Puntarenas, *Rowlee* 19, 65 and 141 (US); Nicoya, *Cook & Doyle* 645 (US).

PANAMA: Isla Taboga, 2 m. tall, *Woodson, Allen & Seibert* 1478 (G); Isla Taboga, 2–3 m. tall, *Standley* 27039 (US).

COLOMBIA: Santa Marta, *Smith* 582 (G, US).

For a widely ranging member of the section *Varronia* this species shows very little variation. The species usually has an indument of fine, closely appressed hairs. At the northern end of its area of dispersal the hairs, and especially those on the calyx, tend to become spreading. *Cordia insularis* was distinguished on this character.

The plant has for a century been identified, and correctly so, with *C. cana* Mart. & Gal., a species based on material from southern Oaxaca. It

was, however, named very much earlier by Miller in his *Gardeners Dictionary* as *Lantana inermis*. The type of Miller's species, preserved at the British Museum, is an unmistakable, very characteristic specimen of the present plant, labeled, subsequent to Miller's time, as having been collected by Houston. According to Miller, "The seeds of this sort were first sent me by the late Dr. Houston, from La Vera Cruz, but I have since received them from Jamaica." The plant, however, is known neither from Jamaica nor from Vera Cruz, Mexico, or their general vicinity. Except for mistakes as to the color of flowers and fruit, Miller's description agrees reasonably well with his type. Even the ambiguous polynomial quoted from Sloane, really applying to a very different plant of Jamaica, might fit our species also.

12. *Cordia bullata* (L.) R. & S. Syst. 4: 462 (1819).

Varronia bullata L. Syst. ed. 10, 916 (1759); *Amoen. Acad.* 5: 394 (1759); *Sp. Pl.* ed. 2, 276 (1762). — Jamaica.

Cordia asperima DC. Prodr. 9: 498 (1845); Urban, *Symb. Ant.* 3: 360 (1903). — Jamaica, Bertero. Not *Cordia asperima* Spreng. Syst. 1: 649 (1825), which is a *Hyptis*.

Varronia asperima (DC.) Friesen, Bull. Soc. Bot. Genève, sér. 2, 24: 155, t. 1, f. 5 (1933).

? *Varronia clarendonensis* Britton, Bull. Torr. Bot. Cl. 41: 16 (1914). — Jamaica, Harris 10995.

The species is known only from scattered localities in Jamaica, Mexico, and Central America.

MEXICO: Xnocac, Yucatan, Gaumer 23479 (G, US); Dzitás, Yucatan, Stewart 372 (G).

GUATEMALA: La Libertad, dept. Peten, Aguilar 171 (G); near Chinana, shrub 1–1.5 m., July 1860, Hayes (G); Fiscal, dept. Guatemala, shrub 18 dm., Standley 59552 (G); near Guatemala City, Tonduz 630 (G, US); barranca near Guatemala City, 2.5–3 m., 1860, Hayes (G); indefinite, Heyde 171 (US).

SALVADOR: near Chalchuapa, Calderon 1002 (G, US).

NICARAGUA: near Granada, Maxon, Harvey & Valentine 7612 (G, US).

HONDURAS: Zamorano, dept. Morazan, Valerio 140, 175, and 1157 (G); Medina near Coyoles, dept. Yoro, Yunker, Koepper & Wagner 8637 (G).

JAMAICA: Farm Pen, Spanish Town, Campbell 5857 (NY); Yardly Chase, Harris 9671 (NY); upper Clarendon, Harris 10995 (TYPE of *V. clarendonensis*, NY); Indefinite, Wille (G); Union Hill, north slope of Mt. Diable, Maxon 10417 (US).

The species has a close relative in the widely distributed *C. globosa* (Jacq.) HBK. and in *C. Bonplandii* (Desv.) R. & S. of northern Venezuela. It differs from the Venezuelan plant by having much smaller leaves and much smaller heads with less thickened calyx-tips and more elongate peduncles. Although *C. bullata* practically always can be separated at a glance from the closely related *C. globosa*, no single character has been found that decisively separates them. There are numerous differences, but these do not vary together and are not always positive. Although an honest statement of differences in the key may not be very impressive, I am of the opinion that *C. bullata* and *C. globosa* are two species worthy of recognition. Of the two, *C. bullata* is more loosely branched and has more slender and more woody twigs. Its leaves are usually ovate, sharply and frequently doubly serrate, and are sharp-pointed at the apex. They

are usually a darker green than the lanceolate or elliptic, usually bluntly toothed thinner leaves of *C. globosa*. The leaf-veins are usually much branched and anastomosing to form an evident reticulum that is usually prominent on the lower face and frequently evident as impressed lines on the upper face. The lower surface of the leaf, and generally the upper also, is therefore broken up into small areoles a few millimeters in breadth. This is generally most evident on old, very mature foliage. The upper surface has short stiff ascending bristles, usually arising from bulbous mineralized bases. On hardened old leaves, on which the veins are well impressed on the upper surface, usually only one to several bristles arise from within each areole. On the lower leaf-surface the vein-reticulum may be moderately prominent on lush new foliage or, in some plants, partially hidden by an abundance of appressed hairs. Usually, however, and especially on hardened old leaves, the reticulum on the lower leaf-face is prominent and conspicuous. The areoles on the lower face in herbarium material, when examined under a lens, usually reveal a rather distinctive development of this species. In drying there is shrinkage of tissue beneath many of the thick bases of the major bristles on the upper surface. Accordingly, within the areoles on the lower surface there are usually present tiny concave depressions. A suggestion of this development may be detected very rarely in some specimens of *C. globosa*. In *C. bullata*, however, it is practically always present, at least in some degree, and in most specimens is very evident when looked for. The flowers of *C. bullata* are borne in heads averaging perceptibly smaller than those in *C. globosa*. The peduncles of *C. bullata*, furthermore, usually become distinctly more elongate than those of its relative. The tips of its calyx-lobes tend also to be thicker and somewhat shorter than in *C. globosa*. The corolla of *C. bullata* seems to be always small. Its short tube is very hairy within and swells only moderately to form a subcampanulate throat. The usually larger corolla of *C. globosa* is funnellform with the tube flaring into a widely dilating throat. It has a well-defined hairy band inside the tube. In *C. bullata* the band is less well defined and hairs frequently occur proportionately much lower down on the tube surface.

The name *Cordia bullata* (L.) R. & S. is clearly the oldest name for the plant of Jamaica later described as *C. asperrima* DC. It was originally published as *Varronia bullata* L. Syst. ed. 10, 916 (early 1759) and treated as follows: "bullata. B. V. fol. ovatis venoso-rugosis, spicis globosis. Sloan. jam. t. 195, f. 1." The descriptive details and the cited plate both apply to the Jamaican plant later called *C. asperrima*. The name *V. bullata* next appears in the literature associated with the short original description of a Jamaican specimen collected by Browne. This was published by Elmgren, one of Linnaeus's students, Amoen. Acad. 5: 394 (Nov. 1759). The plant described is that now catalogued in the Linnaean Herbarium as no. 255.2 and is also the one discussed at length by Smith in Rees Cyclopaedia, 36: sub *Varronia bullata*. Jamaican *Cordia asperrima* is clearly represented. A month after Elmgren published his dissertation, another was published by Sandmark, Amoen. Acad. 5: 376 (Dec. 1759),

in which the name *V. bullata* was again mentioned. In this case it was associated with the first of the *Varronias* treated on page 172 of Browne's History of Jamaica. Browne's descriptive matter is ambiguous, but the plate cited, t. 13, f. 2, evidently represents the northern form of *C. globosa*. The fourth appearance of the name *V. bullata* is in the second edition of the Species Plantarum, 276 (1762). Linnaeus gave only two references as basis for the name, the first being Elmgren's description of *C. asperrima* and the second Jacquin's account of the utterly different *V. mirabiloides*.

It is to be noted that *Lantana bullata* L. Sp. Pl. 627 (1753), although a species of *Cordia*, is not synonymous with *Varronia bullata* L. Syst. ed. 10, 916 (1759). In the Species Plantarum, ed. 2, 276 (1762), Linnaeus correctly cites *Lantana bullata* as a synonym of *Varronia curassavica*.

13. *Cordia globosa* (Jacq.) HBK. var. *humilis* (Jacq.), comb. nov.
Varronia humilis Jacq. Enum. 14 (1760); Sel. Stirp. 41 (1763).—Jamaica.
Cordia humilis (Jacq.) Don, Gen. Syst. 4: 383 (1838).
Lithocardium corymbosum var. *humile* (Jacq.) Kuntze, Rev. Gen. 2: 438 (1891).
Cordia jacmeliana Krause, Beih. Bot. Centralb. 32: 344 (1914); Urban, Symb. Ant. 8: 579 (1921).—Jacmel, Haiti, Krause.
Varronia jacmeliana (Krause) Friesen, Bull. Soc. Bot. Genève, sér. 2, 24: 177 (1933).
Varronia humilis var. *mexicana* Friesen, Bull. Soc. Bot. Genève, sér. 2, 24: 162, t. 1, f. 4 (1933).—Morelos, Mexico, Pringle 6346.
Varronia mexicana Friesen, Bull. Soc. Bot. Genève, sér. 2, 24: 162 (1933).
MEXICO: Mazatlan, Sinaloa, *Rose, Standley & Russell* 13719, 14136 (US), *Howell* 10546 (US), and *Rose* 3108 (US); La Constancia, Sinaloa, shrub 4 m., *Ortega* 5518 (G, US); between Rosario and Acaponeta, Sinaloa, *Rose* 1871 (G); Topolobampo, Sinaloa, 1897, *Palmer* 180 (US); Culican, Sinaloa, shrub 2–3 m. tall, *Gentry* 7081 (G) and 7087 (G); Colima, 1897, *Palmer* 52 (G, US); Zitacuaro to Laureles, Michoacan, shrub 4 m., *Hinton* 13209 (G, US); Ixtapan, Mexico, tree, *Hinton* 1164 (G, US); near Cuernavaca, Morelos, 3–4.5 m. tall, *Pringle* 6346 (G, US); Yautepec, Morelos, *Rose, Painter & Rose* 8547 (G, US); San Luis Tultitlanapa, Puebla, *Purpus* 2472A (G, US); Mt. Male, near Porvenir, Chiapas, *Matuda* 4661 (G); Cosumel Island, *Gaumer* 126 (G); Izamal, Yucatan, *Gaumer* 891 (G, US); Progreso, Yucatan, *Lundell* 7961 (G, US).

GUATEMALA: between Rio Hondo and Santa Cruz, dept. Zacapa, shrub 2 m. *Standley* 74084 (G); Zacapa, shrub 2–3 m. tall, *Standley* 73627 (G) and 73964 (G); Chiquimula, shrub 2 m., *Standley* 73967 (G); between San Ildefonso and Cuilco, dept. Huehuetenango, *Steyermark* 50751 (G).

SALVADOR: La Libertad, shrub 1–3 m., *Standley* 23218 (G, US); Acajutla, shrub 1.5 m., *Eyerdam & Beetle* 8735 (G, US).

NICARAGUA: base of Coseguina Volcano, *Howell* 10256 (G); Santiago Volcano near Masaya, *Maxon* 7678 (US); Managua, *Chaves* 386 (US).

PANAMA: Punta Paitilla, shrub 1–2.5 m. tall, *Standley* 26268 (G, US).

The widely ranging *Cordia globosa* breaks up into two geographic varieties. The northern and western plants, those found from Florida and northwestern Mexico south through the Greater Antilles and Central America, are here distinguished as the var. *humilis*. Typical *Cordia globosa*, a plant of the Lesser Antilles, Trinidad, Venezuela, and eastern Brazil, has larger, more pointed (acute or acuminate) leaves sharply serrate on the margins. Its flower-heads are also larger. These two varieties of the species are to be detected in any large and representative

suite of specimens. The differences are not always positive, especially in the Lesser Antilles, but serve reasonably well for the separation of northern and southern plants.

The variety is typified by the Jamaican plant described and illustrated as the "Round spiked *Varronia*" by Browne, Hist. Jam. 172, t. 13, f. 2, since Jacquin specially mentioned it when he described *Varronia humilis*. The plant described as *V. globosa* by Jacquin is evidently the southern plant. He stated that it resembled his *V. martinicensis*, but differed in flowers and inflorescence. In size and form of leaves the southern plant is indeed very similar to *C. martinicensis* as illustrated by Jacquin, Sel. Stirp. 41, t. 32 (1763).

14. *Cordia curassavica* (Jacq.) R. & S. Syst. 4: 460 (1819).

Varronia curassavica Jacq. Enum. 14 (1760) and Sel. Stirp. 40 (1763).—Curaçao.

Lantana bullata L. Sp. Pl. 627 (1753). Not *V. bullata* L. (1759) nor *C. bullata* R. & S. (1819).—Jamaica.

Varronia macrostachya Jacq. Enum. 14 (1760) and Sel. Stirp. 41 (1763).—Cartagena, Colombia.

Cordia macrostachia (Jacq.) R. & S. Syst. 4: 461 (1819).

Cordia brevispicata Mart. & Gal. Bull. Acad. Brux. 11²: 331 (1844).—Tehuacan, Puebla, Galeotti 7192.

? *Cordia peruviana* var. *mexicana* DC. Prodr. 9: 491 (1845).—Campeche.

Cordia linearis DC. Prodr. 9: 493 (1845).—Mexico, herb. Pavon.

Cordia hispida Benth. Bot. Sulphur 139 (1845).—Gulf of Fonseca, Sinclair.

Cordia Palmeri Wats. Proc. Am. Acad. 24: 62 (1889).—Guaymas, Sonora, Palmer 281.

Cordia socorrensis Brandeg. Erythea 7: 5 (1899).—Socorro Island, Anthony 384.

Cordia linearis var. *hypomalaca* Greenm. Field Mus. Pub. Bot. 2: 338 (1912).—Cerro San Felipe, Oaxaca, Conzatti 1831.

Cordia imparilis Macbride, Contr. Gray Herb. 49: 16 (1917).—Banio nuevo, Michoacan or Guerrero, Langlissé 265.

Cordia chepensis Pittier, Contr. U. S. Nat. Herb. 18: 253 (1917).—Chepo, Panama, Pittier 4511.

Cordia littoralis Pittier, Contr. U. S. Nat. Herb. 18: 253 (1917).—Porto Limon, Costa Rica, Pittier 3641.

Cordia mollis Pittier, Contr. U. S. Nat. Herb. 18: 294 (1917).—between Guatemala City and Salama, Pittier 134.

Ranging from Mexico and Cuba south through Central America and the West Indies into northern South America. In Mexico the plant grows along the Pacific slope in the western and southern parts of the country, extending as far north as middle Baja California and middle-western Sonora. Only in Yucatan is it found on the Caribbean slopes of Mexico. In Central America it occurs on both slopes but apparently with greater frequency on the Pacific.

The species is very widely ranging and includes very diverse forms. It has accumulated a formidable list of synonyms. The names given above include only the very oldest few and those based upon plants originating in Mexico and Central America. Although readily distinguishable by its inflorescence, our plant has been frequently confused with *C. cylindrostachya* (R. & P.) R. & S. and its allies, of northwestern South America. The latter range along the Andes from Colombia to Bolivia and produce most of their spikes directly from leaf-axils along leafy twigs, only the

very first produced on the shoot being terminal. The spikes of *C. curassavica*, on the other hand, are all terminal. By subsequent elongation of the twig, however, the spikes may appear to arise from stem-forks or, still on naked peduncles and without subtending leaves, from internodes along leafy stems. None of the spikes in *C. curassavica* ever arise from the leaf-axils.

The oldest name for this widely distributed plant is *Lantana bullata* L. Sp. Pl. 627 (1753). The description of the species records it as "spicis oblongis" and as originating in Jamaica. Linnaeus's knowledge of it was apparently derived entirely from the writings of Plukenet and Sloane. Of the three references given, one is to the works of the former and two to the latter. The first given is to Plukenet, Alm. 329, t. 221, f. 3, and clearly applies to a form of *C. curassavica*. The second reference, *Periclymenum . . . folio majore oblongo bullato . . .*, Sloane, Hist. 2: 81, applies to a close relative of *C. curassavica*. The third reference, however, *Periclymenum . . . folio majore subrotundo bullato*, Sloane, Hist. 2: 81, t. 195, f. 1, involves a very different species, one bearing flowers in heads, which Linnaeus, Syst. ed. 10, 916 (1759), later distinguished as *Varronia bullata*. In the second edition of the Species Plantarum 2: 276 (1762), Linnaeus cited *Lantana bullata* (without name) as a synonym of *Varronia curassavica* Jacq. Of the three references originally given for *Lantana bullata* only the first of the two Sloanean ones is repeated in his synonymy of Jacquin's species. It is to be particularly noted that the significant phrase, "spicis oblongis," first used in 1753, again appears in his diagnosis of *C. curassavica*. Although the name *Lantana bullata* L. (1753) much antedates *Verronia curassavica* Jacq. (1760), it cannot be transferred to *Cordia* or *Varronia*, since the resulting combination would be a homonym of *C. bullata* R. & S. (1819) or *V. bullata* L. (1759).

The next available names for our plant are *Varronia curassavica* Jacq. and *V. macrostachya* Jacq. These were first published in Jacquin's Enumeratio, p. 14 (1760) as follows:

"*curassavica* 1. VARRONIA spicis oblongis; foliis lanceolatis. h *Brown. Jam. 2. p. 172.*

"*macrostachya* 2. ——— spicis oblongis; foliis lanceolato-oblongis. h ." Three years later they were again treated, with more detail, by Jacquin, Sel. Stirp. p. 40-41 (1763), as follows:

"1 VARRONIA spicis oblongis; foliis lanceolatis. *Varronia assurgens* sarmentosa, foliis & capitulis oblongis. *Brown. jam. 2. p. 172.* Frutex quindecimipedalis; ramis teretibus, scabris, senioribus ferrugineis. Folia lanceolata, acuta, serrata, rugosa, venosa, facie scabra, petiolata, alterna. Spicae densae, terminales, duos tresve pollices longae, insidentes pedunculo bipollicari. Flores parvi, inodori. Calycis inflati lacinae subovatae desinunt in denticulos setaceos ejusdem secum longitudinis. Corollae albae tubus longitudine calycem aequat; limbus brevis est & emarginatus. Stamina petalo sunt paulo breviora. Stylus etiam brevis stigmatibus capitato simplicique instructus. Drupa rubra & parva est. Habitat in Curaçao in sepius arboreis.

"2. VARRONIA (*macrostachia*) spicis oblongis; foliis lanceolato-oblongis. Arbuscula erecta, duodecimipedalis. Spicae semipedalis. Folia angusta, semipedalis. Reliqua, ut in praecedente. Habitat Carthagenae in fruticosis & silvaticis."

It will be noted that the trivial name *curassavica* was omitted in the second publication. The lengthy discussion published in 1763, however, evidently applies to *V. curassavica*.

I have come to the conclusion that Jacquin's two binomials apply to forms of a single species. *Varronia curassavica* is the common xerophytic phase, and *V. macrostachya* is the more luxuriant mesophytic phase of the most common of the spicate *Varronias* in northern South America. This is a departure from some recent usage in which *V. curassavica* has been applied to the plant distinguishable as *C. divaricata* HBK.*

The identity of *V. macrostachya* is readily established since there is only one species to which it is possibly applicable that has been found at its type locality (Cartagena) and in ecologically similar stations (Barranquilla, Santa Marta) on the dry north coast of Colombia. Jacquin says that *V. macrostachya* differs from *V. curassavica* in being a shrub 3.6 m. (rather than 4.5 m.) tall, in having spikes 15 cm. (rather than 5–7.5 cm.) long, and in having lance-oblong (rather than lanceolate) leaves reaching 15 cm. in length. The elongate spikes and large leaves indicate that he had one of the luxuriant mesophytic phases of the species repeatedly collected near the ports of northern Colombia.

The specific name selected by Jacquin when he named *V. curassavica* makes it desirable that the binomial should apply to some plant of Curaçao. Only two spicate *Varronias* occur on the island. Judging from the relative number of collections made there, *C. divaricata* must be rare or local on the island, and the xerophytic phase of the plant named *V. macrostachya* must be common and widely distributed there. The latter seems to be the plant to which the name *V. curassavica* belongs. Jacquin's description of the leaves of the island plant, "lanceolate" and "acute," certainly apply best to it. Had Jacquin possessed material of *C. divaricata*, he would certainly have mentioned the hairy upper leaf-faces in distinguishing it from the plant of Cartagena. He does speak of the scabrous leaves of *V. curassavica*, but this almost certainly refers to the harshness resulting from the great numbers of minute siliceous tubercles usually present on the glabrous upper surface of the xerophytic form of *V. macrostachya*. If *V. curassavica* is taken as one of two possible species of Curaçao and is judged by comparisons with *V. macrostachya*, its identity

* A species widely distributed in northern Venezuela and best known from the region about Caracas. It extends into northeastern Colombia and is present on Curaçao and also on Dominica and Martinique. It differs from *C. curassavica* in having leaves broadest at or above the middle, round at the apex, usually strongly crenate or toothed on the margin, and commonly soft-hairy on the upper surface. The calyx-lobes tend to be shorter and proportionately broader, and the corolla-lobes are usually more erose-denticulate and crisped than in *C. curassavica*. *C. cuneiformis* DC. is a synonym.

seems clear. *Varronia curassavica* and *V. macrostachya* are forms of one species.

Some of the details in Jacquin's later discussion of *V. curassavica*, however, are puzzling. They agree neither with *C. divaricata* nor with forms of *V. macrostachya*. They suggest that Jacquin's notes may have been faulty, that he may have been misled by extraneous material associated with his specimens, or that there was some confusion in his manuscript. In the first place he states that *V. curassavica* grew 4.5 m. tall, a height which is certainly unusual if not greatly excessive for the species. Most important, however, he gives the calyx as inflated and having subovate lobes prolonged into setaceous tips. This agrees with the calyx of *Varronia globosa* Jacq., a species with capitate inflorescences common on Curaçao, but certainly not with any of the spicate *Varronias* known from the island or from Venezuela. Indeed almost all of the details given for the flowers of *V. curassavica* could apply better to *V. globosa*. It is surprising that Jacquin, in his description of *V. globosa*, made no mention of the setaceous tips of the calyx-lobes, one of the most conspicuous and distinctive traits of that species. Finding reference to such structures in Jacquin's description of *V. curassavica*, where they certainly do not belong, I am willing to believe that the notes on flowers and fruit appearing there may have been intended for his account of *V. globosa* and were somehow misplaced. Fortunately, the confusion described can be overlooked, since it does not appear in the *Enumeratio* (1760), where the species were established. It appears only in the *Stirpium* (1763), his second amplified treatment of the species, where by oversight even the specific name "*curassavica*" was omitted. Since we are able to associate it with one of the two spicate *Varronias* of Curaçao, the name *V. curassavica* can be used. Moreover, it is preferred to *macrostachya* in combining Jacquin's two species, since it belongs to the species originally given priority of position and a fuller discussion. Also it has been more frequently used by subsequent authors and is hence the more familiar name.

In the present paper I have defined *C. curassavica* very broadly, for the simple reason that I have not had time to give the Mexican and Central American plants of this complex group the study they need. I have included under it some very diverse forms which will almost certainly be treated eventually as separate species. The diverse forms of Mexico and certain hairy plants of Central America are in many ways more similar to plants of the Greater Antilles than to typical *C. curassavica*, and must be studied with the former.

Typical *C. curassavica* is known only from northern South America from the Guianas to Colombia, and extends north only to Martinique and Yucatan. In our region it has synonyms in *C. chepensis* Pittier and *C. littoralis* Pittier. It is the only form of the present aggregate found in Panama. Specimens in the Gray Herbarium representing typical *C. curassavica* from Central America are as follows:

PANAMA: Chepo, Pittier 4511 (*C. chepensis* Pittier); Balboa, Standley 25552 and 27152; Ancon Hill, Killip 12059; Race Track near Panama, Standley 27795; Bella

Vista, *Maxon & Valentine* 6945; Miraflores Lake, *White* 244; Isla Taboga, *Woodson, Allen & Seibert* 1485; Aguadulce, *Coclé, Pittier* 4860; between Aguadulce and Anton, *Woodson, Allen & Seibert* 1207; El Valle, *Coclé, Allen* 100 and 753, *Seibert* 439; between Las Margaritas and El Valle, *Woodson, Allen & Seibert* 1293; Manzanillo Island, *Hayes* 5; Chagres, *Fendler* 130; near Chiriqui Lagoon, Bocas del Toro, *Wedel* 562, 2478, 2608, and 2923.

COSTA RICA: Port Limon, *Pittier* 3641 (*C. littoralis* Pittier).

SALVADOR: Acajutla, *Beetle* 8730.

NICARAGUA: San Juan del Norte, *C. L. Smith* 91.

GUATEMALA: Jutiapa, *Standley* 75263.

BRITISH HONDURAS: Manatee Lagoon, *Peck* 65; Lower Belize River, *Record*; New Town, *Schipp* 821; Bakers Pine Ridge, *Lundell* 7002; Honey Camp, *Lundell* 508; San Antonio, Corozal, *Lundell* 4986.

MEXICO: Yucatan, Chankon, *Bequaert* 84; indefinite, *Gaumer* 24027 and 24234; Quintana Roo, Lake Coba, *Lundell* 7686; Campeche, Hecelchakan, *Stewart* 11.

15. *Cordia costaricensis*, sp. nov.

Frutex scandens, ramulis minute brunneo-pubescentibus, internodis 1–7 cm. longis; foliis alternis late lanceolatis penninervis reticulato-venosis, majoribus 10–15 cm. longis et infra medium 5–6 cm. latis, apice acutis acuminatisve, basi obtusis vel rotundis, margine minute sed distincte serratis, facie superiori minute papillatis pilis rigidis ad 0.5 mm. longis plus minusve donatis rare subglabris, facie inferiori pilis minutis mollibus 0.2–0.5 mm. longis plus minusve donatis; petiolo 1–3 cm. longo cum pedunculo vel ramo axillari basi connato; spicis densis vel laxis 2–8 cm. longis ad 8 mm. crassis 1–3 cm. longe pedunculatis in paniculis laxis 15–25 cm. longis terminalis vel axillaribus paucissime foliatis gestis; calyce sessile fere ad medium lobato, in alabastro late obovato 2–3 mm. crasso summum ad apicem rotundatum apices liberes loborum 0.2–0.5 mm. longas prore-renti, extus subglabro vel supra medium pilis minutis rigidulis sparse obsito, intus glaberrimo, sub anthesi 4–5 mm. longo basi et paulo supra basem 1–1.5 mm. crasso deinde sursum gradatim ampliato apice 4–5 mm. diametro; lobis calycis ascendentibus deltoideis vel ovato-deltoideis, apice apiculatis et subincrassatis, sinibus acutis; corolla campanulata 5–6 mm. longa, basi 1.5–2 mm. crassa ceinde sursum ampliata, apice 5–6 mm. diametro, margine erosa haud lobata, extus glabra, intus sub insertione staminum villosa alibi glabra; staminibus inclusis, antheris 1 mm. longis, filamentis 2.5 mm. longis; ovario cum stylo glabro; fructu ignoto.

COSTA RICA: Vicinity of El General, prov. San Jose, 1190 m. alt., scandent shrub, edge of forest, fl. white, Aug. 1936, *A. F. Skutch* 2828 (TYPE, Gray Herb.); Vara Blanca de Sarapiquí, north slope of Central Cordillera, 1500–1750 m. alt., in thicket, fl. white, July–Sept. 1937, *Skutch* 3175 (G).

A very well marked species with its closest relations in *C. multispicata* Cham. of eastern Brazil. From that species it differs in its somewhat larger and more elongate leaves, axillary panicles of spikes, and tubular erose-margined corollas.

16. *Cordia spinescens* L. Mant. 2: 206 (1771). — “India orientali.”

Varronia ferruginea Lam. Tab. Encyc. 1: 418 (1791); Poir., Encyc. 4: 263 (1797);

Desv. Jour. de Bot. 1: 266, t. 9 (1809). — Based on plants cultivated at Paris.

Cordia ferruginea (Lam.) R. & S. Syst. 4: 458 (1819).

Cordia riparia HBK. Nov. Gen. et Sp. 3: 71, t. 207 (1818). — Type from Mom-pox, Magdalena Valley, Colombia.

Cordia laxiflora HBK. Nov. Gen. et Sp. 3: 72 (1818). — Between Mom-pox and Morales, Magdalena Valley, Colombia.

Cordia pyrifolia Willd. ex R. & S. 4: 802 (1819).—South America.

Cordia Thibaudiana DC. Prodr. 9: 489 (1845).—America.

Cordia crenulata A.DC. Prodr. 9: 492 (1845).—Mexico, *herb. Pavon*.

Varronia crenulata Sessé & Moc. Fl. Mex. 48 (1893), ed. 2, 44 (1894).—From Orizaba, Mexico.

Cordia pauciflora Rusby, Mem. Torr. Bot. Cl. 6: 83 (1896).—Near Cochabamba, Bolivia, *Bang 1291*.

Ranging from Mexico southward through Central America into Colombia and from there south along the Andes to Bolivia. In Mexico it is practically confined to lower altitudes towards the coasts and is found as far north as Nayarit and middle Vera Cruz. Most of the many specimens examined come from Mexico, Guatemala, and Panama.

This species has been called *C. ferruginea* (Lam.) R. & S. It has, however, an older name in *Cordia spinescens* L. This latter was based upon a specimen still preserved in the Linnaean Herbarium. It was launched with a detailed description, but, unfortunately, was mistakenly said to be an East Indian plant. Unrecognized by botanists in the Old World and unstudied by botanists in America the species has remained neglected and unplaced. No *Cordia* remotely suggesting it is known from the Old World. It is, however, indistinguishable from the well-known American species usually called *C. ferruginea*. The type of *C. spinescens* has a few spikes and numerous developing axillary shoots and the general appearance of growing in a botanic garden away from its natural environment. I suspect that it may have been grown from seeds sent from Colombia by Mutis or have been derived from plants of other sources grown at Madrid or Paris. The species is known to have been in cultivation in Europe in the late eighteenth century. The synonymous *C. ferruginea*, indeed, was based on plants growing at Paris sometime previous to 1791. The specific name "*spinescens*" adopted by Linnaeus refers to the decurved spurs, persisting indurated basal portions of petioles, that are very well developed along the clambering shoots of this shrub.

B. THE IDENTITY OF SPECIES PROPOSED BY SESSÉ AND MOCIÑO

A very large number of puzzling species were published about fifty years ago, when the manuscripts of Sessé & Mociño were dug out of the archives at Madrid and printed in Mexico as the "Flora Mexicana" and "Plantae Novae Hispanicae." The Boraginaceae described in these works mostly defied identification. On various trips to Europe, accordingly, I methodically recorded the data on all specimens believed to be collections of Sessé & Mociño. Notes were also made on the set of Mociño drawings at Geneva. In 1936, when the Sessé & Mociño herbarium at Madrid was loaned to the Chicago Natural History Museum for study, I was allowed to examine all the Boraginaceae it contained. With data assembled from the sources mentioned it is now possible to identify with reasonable accuracy the species first published in the posthumous writings of Sessé & Mociño. Only those species which the authors themselves obviously in-

tended as new proposals are here discussed, since only these have any nomenclatorial importance. The many misidentifications contained in the work are properly ignored.

The specimens from Madrid commonly bear the identification of Sessé & Mociño and frequently also their collection number, but never any geographical data. To facilitate reference, a new set of herbarium numbers was applied to the sheets in the collection after it arrived at Chicago. In referring to the Sessé & Mociño material belonging to Madrid, this new set of numbers has been used. For each collection mentioned I have given its recently assigned number, and, when it is not an unpublished binomial, have given the Sessé & Mociño identification also.

The study of the Sessé & Mociño borages has made it clear that the authors either collected in northern Mexico or had collaborators there. In the past it has been generally stated that their material came only from central and southern Mexico, Guatemala, Cuba, and Porto Rico. Rickett has recently found proof that northwestern Mexico was another source. Northeastern parts of the country, very likely the vicinity of Monterrey, are also to be included. This is evidenced by the presence in the Sessé & Mociño herbarium of material of *Cordia podocephala* Torr., *Cordia Boissieri* DC., *Ehretia Anacuna* (Berl.) Johnston, and especially *Omphalodes aliena* Gray.

Cordia alliodora (R. & P.) Cham.

Varronia tuberosa S. & M. Pl. N. Hisp. 30 (1888), ed. 2, 28 (1893). — From Metepec, Vera Cruz.

The material of this species assembled by Sessé & Mociño and now at Madrid is numbered and bears original identifications as follows: 752 (*Cerdana*), 1352 (*Varronia tuberosa*), 1366 (*Cordia nodosa*), 1452 (without name), 1568 (*Cordia Gerascanthus*), 1569 (*Cerdana*), 5275 (*Cordia globosa*). A specimen at Oxford is labeled "*Varronia tuberosa*, Mexico ex herb Ruiz."

When *Varronia tuberosa* was described reference was given to "Fl. Mex. Ic. 193." This plate number appears on no. 882 of DeCandolle's copies of the Mociño plates at Geneva. The plate is labeled "*Cordia nodosa*," a name apparently originating with Sessé & Mociño. It is incorrectly cited under *Cordia nodosa* Lam. in the Prodr. 9: 475 (1845).

Cordia diversifolia Pavon ex DC.

Cordia paniculata S. & M. Fl. Mex. 49 (1894), ed. 2, 45 (1894). — Habitat in Opido de la Punta, ? Vera Cruz.

An unidentified specimen at Madrid bears the number 760. It is conspecific and probably a duplicate of at least the Mexican specimen from Pavon's herbarium cited by DeCandolle, Prodr. 9: 474 (1845), when he described *C. diversifolia*.

Cordia dodecandra DC.

Cordia dodecandra S. & M. Fl. Mex. 50 (1894), ed. 2, 46 (1894). — From coast at Alvarado, Vera Cruz.

This species is represented by an unidentified specimen, no. 758 bis, at Madrid, and also by a fine colored plate, tab. 874, among the copies of

the Mociño drawings at Geneva. The plant, bearing the name "*Cordia dodecandra*," is the basis upon which DeCandolle, Prodr. 9: 478 (1845), described the species.

Cordia elaeagnoides DC.

? *Cordia exsucca* S. & M. Fl. Mex. 49 (1894), ed. 2, 45 (1894).—Habitat in Apataingani [Michoacan] aliisque calidissimis Novae Hispaniae locis.

I have seen no material collected by Sessé & Mociño and am able to judge their *C. exsucca* only from the description. This fits *C. elaeagnoides* DC. reasonably well.

Cordia pauciflora DC. ex Ramirez, Estud. Hist. Nat. 295 (1904), not Rusby (1896).

Ramirez identifies plate 877 of the set of Sessé & Mociño plates at Geneva with plate 25 of the set at Madrid and associates them with "*Cordia Sebestena*, Jacq.—Plantae Novae Hispaniae pag. 28. Ic. 36." The plate at Geneva is very sketchy, being only a poor pencil outline. It bears the name "*Cordia pauciflora*," which probably originated with Sessé & Mociño. In general habit the sketch most suggests a species of *Bourreria*. I do not believe it is the same as *Cordia Sebestena* sensu Sessé & Mociño, Pl. N. Hisp. 30 (1888), ed. 2, 28 (1893), which is given as originating in dry fields near Cuernavaca. Ramirez's publication of the name "*Cordia pauciflora*" consists of mere casual mention. No description is given.

Cordia podocephala Torr.

Varronia longifolia S. & M. Fl. Mex. 48 (1893), ed. 2, 44 (1894).—Habitat in Praedio de la Punta, ? Vera Cruz.

A specimen at Madrid, no. 5269, bears the name "*Varronia longifolia* N." The plant is unquestionably conspecific with *C. podocephala*, known only from northeastern Mexico and adjacent Texas. The published description of *V. longifolia* agrees with Torrey's species, also.

Cordia spinescens L.

Varronia crenulata S. & M. Fl. Mex. 48 (1893) ed. 2, 44 (1894).—From the vicinity of Orizaba, Vera Cruz.

Material at Madrid representative of the species is as follows: 739 (*Varronia crenulata*), 740 (without name), 741 (without name), 742 (without name), 5262 (new sp. aff. *spinescens*), 5264 (*Varronia spinescens*), 5273 (*Varronia crenulata*). Judging from similarities in material I would say that parts of only three different collections are represented in the suite cited. The type of *Cordia crenulata* DC., Prodr. 9: 492 (1845), is almost certainly a duplicate of one of these collections.

Ehretia Anacuna (Berl.) Johnston

Ehretia lancifolia S. & M. Fl. Mex. 51 (1894), ed. 2, 44 (1894).—Habitat in Texcoco.

Representative specimens of the species at Madrid are as follows: 773 (*E. lancifolia*), 774 (*Ehretia* sp. nov.), 775 (without name), 5247 (*Ehretia* sp. nov.), 5250 (*E. lancifolia*, communicavit D. Ignatius de Leon, Horti Reg. Mex. Alumnus). Judging from general appearance, the material cited probably consists of duplicates of no more than two different collec-

tions, one bearing the name *E. lancifolia* and the other an unpublished binomial. The species is known as a wild plant only in northeastern Mexico and adjacent Texas, but I have seen cultivated specimens of it from as far south in Mexico as Guanajuato.

Bourreria rotata (DC.) comb. nov.

Cordia rotata Mociño ex DC., Prodr. 9: 483 (1849).

Ehretia calophylla Richard in Sagra, Fl. Cubana 2: 112, t. 61 (1853).

Bourreria calophylla (Rich.) Wright in Sauvalle, Fl. Cubana 110 (1870); Schulz in Urban, Symb. Ant. 7: 52 (1911).

The species described by DeCandolle is based upon a handsome colored plate, no. 880, in the set of Mociño drawings at Geneva. The plate shows a plant with the characteristic forking style of a *Cordia*, but in all other details it is a remarkably good representation of the Cuban plant now current as *Bourreria calophylla*. The forked style is evidently a mistake of the artist.

Bourreria spatulata (Miers) Hemsley

Ehretia cuneifolia S. & M. Fl. Mex. 51 (1894), ed. 2, 47 (1894).—From Chilpanzingo, Guerrero.

Two collections of the species are at Madrid: 1354 (*Ehretia exsucca*) and 5252 (*Ehretia cuneifolia*, olim *exsucca*). A fine original colored plate of the species occurs among the Mociño plates at Geneva, no. 887. It bears an unpublished binomial, under *Ehretia*, and also Mociño's number, 292. This latter was cited when *Ehretia cuneifolia* was described. Miers based his species upon a plant from Pavon's herbarium. The type is almost certainly a duplicate of one of the two Madrid specimens cited above.

Heliotropium angiospermum Murr.

Heliotropium lancifolium S. & M. Fl. Mex. 31 (1893), ed. 2, 29 (1894).—Cuernavaca, Morelos.

Cerinthe lanceolata S. & M. Pl. N. Hisp. 20 (1888), ed. 2, 19 (1893).—Cuernavaca, Morelos.

The herbarium at Madrid contains a number of specimens of this species: 858 (*Heliotropium* sp., *Cerinthe lanceolata*), 1384 (*Heliotropium indicum*), 1718 (*Heliotropium lancifolium*), 1719 (*Heliotropium* sp. nov.), 1722 (*Heliotropium parviflorum*), 5254 (*Heliotropium parviflorum*). Some of the material probably came from Havana and is that treated as *H. parviflorum* in Flora Mexicana 31 (1893), ed. 2, 28 (1894).

Heliotropium assurgens Johnston

Anchusa incana S. & M. Fl. Mex. 33 (1893), ed. 2, 30 (1894).—Cuernavaca, Morelos.

Two specimens at Madrid clearly belong to this species: 931 (*Lithospermum* olim *Anchusa incana*) and 1435 (*Anchusa incana*).

Heliotropium calcicola Fernald

Symphitum fruticosum S. & M. Pl. N. Hisp. 21 (1888), ed. 2, 20 (1893).—Chilpancingo, Guerrero.

There are three specimens at Madrid, 861 (*Heliotropium frutescens*), 1716 (*Heliotropium* sp. nov.), and 5256 (*Heliotropium* sp. nov.). They

are so similar in appearance that they may well be only duplicates of a single collection. At Geneva there is a beautiful plate of the species, tab. 901, labeled *Symphitum fruticosum* and bearing the number 288 of Sessé & Mociño's series of plates. This latter number is cited in Sessé & Mociño's account of *S. fruticosum*. *Antiphytum mexicanum* DC., Prodr. 10: 121 (1846), was based entirely upon the plate at Geneva.

Heliotropium oaxacanum DC.

Lithospermum rosmarinifolium S. & M. Fl. Mex. 33 (1893), ed. 2, 30 (1894).—

From Uruapam, Michoacan.

Anchusa depressa S. & M. Pl. N. Hisp. 21 (1888), ed. 2, 20 (1893).— From Uruapam, Michoacan.

Representative of the species at Madrid is one specimen, no. 5238. This is associated with an unpublished binomial of which "*rosmarinifolium*" is the specific adjective. The descriptions of Sessé & Mociño apply reasonably well to *H. oaxacanum* DC., and I am content to refer this proposed species to the synonymy of it.

Heliotropium Sessei Johnston

Myosotis mexicana S. & M. Fl. Mex. 33 (1893), ed. 2, 31 (1894).— In temperatis N. Hispan. montibus.

Two specimens are preserved at Madrid, 1725 (*Myosotis mexicana*) and 5229 (*Myosotis mexicana*). They are probably duplicates of a single collection. The description of *Myosotis mexicana* fits them reasonably well. The species is known only from Sierra de la Mesa, Hidalgo (*Purpus* 1402 and *Rose, Painter & Rose* 9122) and from Sessé & Mociño's collections cited above.

Tournefortia bicolor Sw.

Tournefortia laevis S. & M. Fl. Mex. 52 (1894), ed. 2, 48 (1894).— Habitat in Novae Hispaniae regionibus.

A specimen at Madrid represents Sessé & Mociño's species, 1712 (*T. laevis*).

Tournefortia hirsutissima L.

Tournefortia odorata S. & M. Fl. Mex. 52 (1894), ed. 2, 48 (1894).— Habitat in Apatzingani [Michoacan].

Several collections of this species are at Madrid, most of them under unpublished names: 1705 (*T. suffruticosa*), 1706 (*Tournefortia* n. sp.), 1707 (*Tournefortia* sp. nov.), 1715 (*Tournefortia* sp. nov.), 5261 (*Tournefortia* sp. nov.). I suspect that no. 1707 may be the type of *T. odorata*. The other collections are perhaps those described as *T. suffruticosa* sensu S. & M. Fl. Mex. 52 (1894), ed. 2, 48 (1894), and *T. cymosa* sensu S. & M. Pl. N. Hisp. 31 (1888), ed. 2, 29 (1893). These latter two names apply to plants from San Juan de los Platanos near Apatzingan, Michoacan.

Tournefortia syringaefolia Vahl

Tournefortia lanceolata S. & M. Fl. Mex. 52 (1894), ed. 2, 48 (1894).— From mountains near Tuxtla, Vera Cruz.

Two specimens representative of *T. syringaefolia* (*T. peruviana*) are found at Madrid: 1711 (*T. lanceolata*) and 5260 (*Tournefortia* n. sp.). One is probably the type of *T. lanceolata* S. & M.

Lithospermum distichum Ortega

Lithospermum laevigatum S. & M. Fl. Mex. 32 (1893), ed. 2, 30 (1894).—Habitat in montibus Predii S. Nicolai [state of Mexico].

? *Anchusa mexicana* S. & M. Pl. N. Hisp. 21 (1888), ed. 2, 20 (1893).—Mountains of Patzquaro, Michoacan.

I have seen two specimens from Madrid representative of *L. distichum*, viz., 1732 (*Lithospermum laevigatum*) and 5226 (*Lithospermum* n. sp.). No specimen identified as "*Anchusa mexicana*" has been encountered. The original description of that species, however, agrees reasonably well with *L. distichum*, and I am content to refer it to the synonymy of the latter.

Lithospermum discolor Mart. & Gal.

Lithospermum obtusiflorum S. & M. Fl. Mex. 32 (1893), ed. 2, 29 (1894).—Habitat in montibus Oppido de El Valle.

Two specimens at Madrid belong here: 1737 (*L. obtusiflorum*) and 5232 (*L. obtusiflorum*). Specimens in the Boissier Herbarium labeled "Nueva Espana, herb. Pavon, *Lithospermum obtusiflorum*," are also referable to *L. discolor*.

Lithospermum strictum Lehm.

Lithospermum angustifolium S. & M. Fl. Mex. 32 (1893), ed. 2, 29 (1894).—From Ario, Michoacan.

Heliotropium mexicanum S. & M. Pl. N. Hisp. 20 (1888), ed. 2, 19 (1893).—Habitat in Sancti Angeli hortis, Valley of Mexico.

Lithospermum rosmarinifolium S. & M. Pl. N. Hisp. 20 (1888), ed. 2, 19 (1893).—Habitat in Oppido Ario, Michoacan. Not *L. rosmarinifolium* S. & M. Fl. Mex. 33 (1893), ed. 2, 30 (1894), which equals *Heliotropium oaxacanum* DC.

Three specimens from Madrid have been seen, viz., 1389 (*Heliotropium mexicanum*), 1734 (*Lithospermum angustifolium*), and 5234 (*Lithospermum angustifolium*). Among the drawings at Geneva there is a poor pencil sketch, no. 1174, labeled "*Heliotropium mexicanum*." In both of the large herbaria at Geneva there are specimens from the Pavon herbarium bearing the name "*Lithospermum angustifolium*." The description accompanying the name *L. rosmarinifolium* in the *Plantae Novae Hispaniae* is a repetition of that associated with *Lithospermum angustifolium* in the *Flora Mexicana*. The names, accordingly, must be synonymous.

Macromeria exserta Don

Echium longiflorum S. & M. Pl. N. Hisp. 20 (1888), ed. 2, 19 (1893).—Habitat in Mazatlani et Chilpanzingi montibus, Guerrero.

One specimen from Madrid has been seen, 859 (*Echium longifolium*). In the library at Geneva there is a fine original plate (no. 903 of the DeCandolle series) which bears Sessé & Mociño's original number, no. 293, and their original name, *Echium longiflorum*. This latter plant-number is cited with the published description of *Echium longiflorum*.

Macromeria longiflora Don

Lithospermum flavum S. & M. Fl. Mex. 32 (1893), ed. 2, 30 (1894).—Mountains between Zitacuaro and Malucatepec, Michoacan.

One specimen from Madrid has been seen, 1738 (*Lithospermum longiflorum*). There is a good plate at Geneva, no. 905, determined by Sessé

& Mociño as a species of *Philonomia*. DeCandolle has identified it with *Macromeria discolor* Benth. A specimen in the Boissier herbarium from Pavon was determined as *Lithospermum longiflorum* as was also Don's type of *Macromeria longiflora* at the British Museum. It should be noted that *M. longiflora* Don was formerly misunderstood and that, as has been shown, Contr. Gray Herb. 92: 93 (1930), it properly applies to the well-marked species later described as *M. discolor* Benth.

Macromeria viridiflora DC.

? *Lithospermum longiflorum* S. & M. Fl. Mex. 32 (1893), ed. 2, 29 (1894).— Santa Rosa near Guanajuato.

Only one specimen from Madrid has been seen, 5231 (*Lithospermum longiflorum*). There are two plates of the species at Geneva. Upon them DeCandolle founded his *M. viridiflora*. One is plate no. 904 of the folio series, and the other is plate 12, f. 1 of the volume of Sessé & Mociño's generic analyses. They were treated as members of the new genus *Philonomia* and associated with the specific name adopted by DeCandolle. The two plates and the specimen from Madrid are evidently conspecific with the plants subsequently treated as *Macromeria* (or *Onosmodium*) *Thurberi*. This latter species, however, is known only from southern Arizona and New Mexico and south along the northern Sierra Madre Occidental to southernmost Chihuahua. In the absence of modern collections from more southern localities it seems well to question old records attributing the species to central Mexico. Rickett, Chron. Bot. 11¹: 29 (1947), has given evidence that Mociño and his artist traversed the area in Chihuahua in which the species is well known. I am inclined to believe that they may have obtained it there.

ARNOLD ARBORETUM,

HARVARD UNIVERSITY.